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REPORT

(DATED 30TH DECEMBER 1903)

ON THE

ORGANISATION AND WORKING

OF

RAILWAYS IN AMERICA

BY

NEVILLE PRIESTLEY,

UNDER SECRETARY TO THE GOVERNMENT OF INDIA,
RAILWAY DEPARTMENT.

LONDON: PRINTED BY EYRE AND SPOTTISWOODE,
PRINTERS TO THE KING'S MOST EXCELLENT MAJESTY.

1904.

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CONTENTS.

	Paragraph
INTRODUCTION	1—5
CHAPTER I.—**Organisation of American Railways**—	6—73
CONSTITUTION—	6—17
Classification of Railways	6
Consolidation of Railways	7—9
Board of Directors	10
President and Vice-Presidents. Appointment of	11—13
Standing Committees. Appointment and duties of	14—16
Vice-Presidents. Powers of	17
Results. Definition of	17
ORGANISATION—	18—36
Mileage under one management limited for reasons given	18—19
Subdivision of duties on railway	20
General Office. Duties described	21
Legal. Duties described	22
Treasury. Duties described	23
Accounts. Duties described	23
Traffic. Duties described	24
Purchasing or Stores. Duties described	25
Real Estate. Duties described	26
Insurance. Duties described	27
Engineering. Duties described	28
Transportation. Duties described	29
Dstrict, the unit	29
General Manager. Duties described	30
General Manager's Staff Officers—	31
General Superintendent of Transportation	31
General Superintendent of Motive Power	31
Chief Engineer of Maintenance of Way	31
Superintendent of Telegraph	31
General Superintendents of Divisions	33
General Superintendent's Staff Officers—	34
Principal Assistant Engineer	34
Superintendent of Motive Power	34
District Superintendent	35
District Superintendent's Staff Officers—	35
District Engineer or Road Master	35
Passenger Train Masters	35
Freight Train Masters	35
Train Despatcher	35
Road Foreman of Engines	35
Master Mechanic	35
Assistant District Superintendent	36

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CHAPTER I.—*continued.*	Paragraph.
MANAGEMENT—	37—52
General Manager's control exercised through Statistics and systematised inspection	37
Success secured by careful selection of officers and by giving them free hand	38—40
Fitness for position only standard of selection	41
Employees of all classes, even College men, required to work up from bottom	42—44
District Superintendents chosen from all departments	45—49
District Superintendent's charge	50
Salaries of Officials	51
Travelling Allowances	52
INSPECTION OF RAILWAY	53—55
APPOINTMENT, TRAINING, AND DISCIPLINE	56—61
Appointments. Rules governing	56—59
Training	60
Discipline	61
CORRESPONDENCE—	62—68
Correspondence discouraged	62
Stenographer	63—66
Typewriters	64
Telephones	65—66
Mutual confidence shown	67—68
ASSOCIATIONS—	69—73
Principal Associations enumerated	69
American Railway Association	70
Classification Committees	71
CHAPTER II.—Statistics	74—93
Control of American railways by Statistics	74
Reasons which led to statistics	75—76
Value attached to statistics	77—79
Half yearly statistics regarded as useless	80
Monthly statistics always kept	80—88
Organisation made useful statistics possible	81
Use made of statistics	82
Standard units for statistics	83
Statistics kept and where prepared	84
Subdivision of main statistics	86—87
Vehicle engine and train-mileage statistics, how prepared	89
Passenger statistics, how prepared	90
Cost of preparing statistics	92
Factors which have made statistics of value	93
CHAPTER III.—Gauge—	94—126
GAUGE—Diversity of	94—112
Diversity of, in America	94—96
Transhipment—how avoided—Process adopted	97—106
Applicability of system to India	107—112
FERRIES—	113—126
Ferries—use of, in America	113—125
Applicability of system to India	126
CHAPTER IV.—Goods Rates—	127—164
RATES FOR GOODS—	127—155
Theory governing fixing of rates	127
American experience	128—136
American and Indian rates compared	137—138
Wholesale rates—Rates for grain and coal compared	140—142
Retail rates—Rates for class goods compared	143

CHAPTER IV.—*continued.* Paragraph.

RATES FOR GOODS—*cont.*

Rates in America lower—Remarks thereon - 144—147
Causes operating against Indian wheat - 148—149
Grain elevators - 150
India—position of, as to Rates - 151—152
Fruit traffic - 154
Hay traffic - 155

CLASSIFICATION OF GOODS—Machinery employed for the - 156—159

QUOTATION OF RATES—Procedure normally adopted - 160—164

CHAPTER V.—**Train Loads**— - 165—197

LOADS OF TRAINS— - 165—177
Low cost of transportation due to heavy engines and wagons - 165
Experiments show draw-bar-pull important - 166
Lessons learnt from experiments - 167—171
Effect of traffic in small lots how overcome - 172
50-ton vehicle regarded as economical - 172
Movement of heavy cars by hand facilitated by use of pinch bars - 173
Economies in maintenance not yet demonstrated - 175
India—application of heavy engine to - 176
India—position of, in regard to heavy car - 177

OUTLAY TO SECURE HEAVY LOADS— - 178—184
What America has done - 178—182
What India can do - 183—184

WATER TROUGHS; Importance of keeping wheels going round - 185—187

POOLING OF ENGINES— - 188—197

CHAPTER VI.—**Passenger Traffic**— - 198—229

PASSENGER FARES— - 198—201
Fares on American Railways - 198
American and Indian fares compared - 199—200
Currency of tickets unlimited - 201
Forms of tickets used - 201

PASSENGER SERVICE— - 202—206
Steps taken to develop passenger business - 202—206

PASSENGER CARS— - 207—213
Passenger vehicles, all end-opening bogie type - 207
Passenger car for suburban service - 208
Passenger cars have no sunshades - 209
Ventilation of cars—Suggestions for cooling them - 210
Communication between passengers and train staff - 211
Description of accommodation provided - 212
Dining cars - 213

TIME TABLES— - 214—215
Changes in timings, how arranged for - 214
Passenger trains, how numbered - 215

PASSENGER STATIONS— - 216—217
Design of station - 216
Platform conveniences - 217

LUGGAGE— - 218—225
American system - 218—221
Baggage master with train - 222
Hand barrows plentiful - 223
Arrangements in Inwards Baggage room - 224

PARCELS—Work done by Express Companies - 226—229

	Paragraph.
CHAPTER VII.—**Running Powers and Independent Junctions**—	230—235
Running Powers	230—233
Independent Junctions	234—235
CHAPTER VIII.—**Working of Trains**—	236—277
Train Despatcher System	236—251
Train Despatcher explained	236—240
Mileage operated under it	241
Number of Train Despatchers employed	242—244
Risks taken—American conditions justified system	245—248
Goods trains arrangements bad	249—251
Automatic Train Signalling—	252—258
Systems used described	252—256
System for single lines	257
Electric Train Staff system	258
Working of four track lines	259—262
Telephone—Use of, for train signalling	263
Signals	264
Trains—Marshalling of	265—275
Making up of loads	265
Pusher and helper engines	266
Shunting yards, remarks about	267—268
Fly-shunting disapproved of	269
Poling—System of shunting by, explained	270—271
Facilities to expedite shunting	272—275
Passenger Train Yards	276—277
CHAPTER IX.—**Goods Traffic**—	278—356
Outwards Goods—	278—310
Car load traffic—Method of handling described	280—286
Form of Forwarding Note and Receipt	281
Less than car load traffic, handling of, described	287—288
Outwards Goods—System followed at Chicago for	289—305
Invoicing—System of, explained	306
Clearing House	307
Invoices—tissue copy only sent Auditor	308
Do. Do. sent Traffic Officers	309
Inwards Goods, System followed at Boston	311—322
Cash Remittance—System explained	323—330
Car Record—	331—356
Record of movement of wagons, how kept	331—332
System on Great Northern Railroad described	333—344
Daly's system in regard to Fast freight	346—356
CHAPTER X.—**Labour-Saving Devices**	357—367
CONCLUSION	368

	Page.
APPENDIX A.—Dr. C. H. Williams' Lantern for testing colour blindness —Description of	117
„ B.—Plan of Boston Terminal Station	119
„ C.—Hollerith's Electric Tabulating Machine—Description of	121

REPORT

ON THE

ORGANISATION AND WORKING

OF

RAILWAYS IN AMERICA.

INTRODUCTION.

In Earl Percy's Letter, No. P.W. 558 of the 30th June 1903, I was informed that the Secretary of State for India in Council, in accordance with the recommendation of the Government of India, authorised me "to visit "America with the view of studying the methods of working in the Traffic "Department on Railways in that country," on the understanding that I would "submit to him a Report, giving the result of your observations, for transmission to the Government of India"; and I was "placed on duty for a period not exceeding two months" for this purpose.

2. I took the liberty of construing the expression "working in the Traffic Department" in its widest sense. In India, the Traffic Department includes not only what is known in America as the Traffic Department, that is, the department which deals with the commercial side of the business fixing the rates and fares and issuing the tariffs, but also the department which conducts the transportation of the traffic when it has been obtained. The success of a railway, from the point of view whether of the shareholder or of the public, depends, to no small extent, on the Transportation department. All the other departments are really only complementary to it; and to comprehend correctly its management and working, it was necessary to study as a whole the organisation of the great railway systems now operating in America.

3. To do this at all satisfactorily in the time given me, I thought it would be better to avoid "scattering," and to limit my enquiries to a few railways. I accordingly devoted my attention to four or five of the systems which were recognised to be the best operated in the country. I chose these in preference to the less advanced railways, because, in the first place, the best and most up-to-date practice was to be found on them and it is only the best we should desire to imitate, and, because, in the second place, all railway problems are similar and the size of a railway or the volume of its traffic only makes these problems differ in degree.

4. Thanks to the courtesy of Mr. Robert Miller, Managing Director of the Bengal-Nagpur Railway, I obtained letters of introduction from Lord Rothschild to the Banking Houses of August Belmont & Co. of New York. Lee, Higginson & Co. of Boston, and the Bank of California, San Francisco; from Sir Ernest Cassel and Sir Clinton Dawkins to Mr. James J. Hill, President of the Great Northern Railroad; and from Sir Clinton Dawkins to Mr. Samuel Spencer, President of the Southern Railroad. These together with other letters from friends in England and America, obtained for me personal introductions to the Presidents and the higher officials of the roads I visited, and proved of the very greatest value to me.

If one thing struck me more than any other in the great railroad, in fact in the great business, world of America, it was the extreme courtesy of every one with whom I was brought in contact. The greatest consideration and kindness were always shown me, and I cannot adequately acknowledge my obligation. Mr. A. J. Cassatt, the President of the Pennsylvania Railroad, placed me in the way of getting much valuable information from his officers, and, to facilitate my enquiries, sent me over his road by special train, a journey of three days, on which I was accompanied, from Philadelphia to Pittsburg by the late General Manager of the system, Mr. J. B. Hutchinson, and from Pittsburg to Chicago by Mr. G. L. Peck, General Manager of the Pennsylvania lines west of Pittsburg, and by all the divisional officers over their respective districts. Mr. Stuyvesant Fish, President of the Illinois Central Railroad, took me out to his place in the country and devoted two complete days to me. Mr. James J. Hill, President of the Great Northern Railroad, gave me several hours of his time.

It was the same with all the other officials from the President downwards, with whom I was brought in contact. They spared neither time nor labour—and I made great inroads on both—to give me all the information and assistance I needed.

To assist my enquiries, I also found it necessary to see Professor Arthur Hadley, President of Yale University; Mr. Woodlock, Editor of the Wall Street Journal; Mr. W. H. Boardman, Editor of the Railroad Gazette, to whom I am beholden for much useful assistance; the Chief of the Bureau of Statistics and the Chairman of the Inter-State Commerce Commission at Washington; and the Chief of the Labour Bureau at Boston.

I must not omit Mr. Merle Middleton of the Baldwin Locomotive Works, Philadelphia, to whom I am greatly indebted for placing me in touch with people who were likely to be most helpful to me.

5. I went to America not to criticise but to obtain instruction; and as a desire was expressed in more than one place, that names should not be given, I have, as far as was possible, avoided mentioning names of railways.

With the large systems operated in America, there must necessarily be differences, sometimes great differences, in the details of management and operation. To describe the procedure followed on each of the railways in any particular matter, would needlessly overburden the report. I have, therefore, taken such details as, in my judgment, appeared to afford the best practice, and have worked them into one consecutive whole. The procedure thus described, taken as a whole, will seldom be found to exist on any individual railway, but the counterpart of one or more (generally more) of the details comprising that whole, will be found on some one of the systems I visited.

In making my investigations, I kept in mind the conditions which exist in India generally. In preparing my report, I have confined myself, as far as possible, to a presentation of such American practices as, *mutatis mutandis*, might be adapted to Indian conditions. How they may be adapted, I have left it to my readers to decide for themselves, as local conditions must affect the suitability or otherwise of any scheme which may be suggested *when taken as a whole*, and there must always be differences of opinion as to details.

My own observations, where I have ventured on any in relation to Indian railways, will generally be found at the conclusion of each Subject.

CHAPTER I.

ORGANISATION OF AMERICAN RAILWAYS.

CONSTITUTION.

Classification of railways.

6. The railways in America may be divided broadly into two classes, namely,—

(A) those in which the shares are held by numerous stockholders, no one of whom has a preponderating interest in the property; and

(B) those in which a preponderating number of the shares is now held by a few, a very few, individuals having a common interest, or by some other railway company in its corporate capacity.

In this class would fall such railways as have been leased on definite terms to other railways, in the management of which the stockholders have no longer any voice; as also such railways as are operated by the trunk lines under agreements, but which are so situated as not to be able to affect in any way the policy of the trunk line.

All these lines or systems are, for brevity, termed Consolidated Lines in this Report.

Benefits resulting from Consolidation.

7. This process of amalgamation has been going on now for several years, and it was explained that the benefits the country has derived by the arrangement were—

(i) to passengers, it has been possible to give a much better service by the introduction of *through* trains to serve the whole of the territory traversed by the consolidated lines, whereas, before, opposing interests prevented such a service, or only made it practicable with great difficulty; and

(ii) to the goods business it ensured certainty of rates, it allowed of the whole area operated being treated as one undertaking, and it permitted of traffic being carried more expeditiously and economically.

Benefits borne out by experience.

8. That the public have not suffered by consolidation would appear to be generally conceded, and there is ample evidence of the benefits they have derived in the directions claimed. By enlarging the systems much economy has been effected in the cost of operation, with corresponding increase in the profits. As a consequence, the credit of the corporation improved, and railways have in recent years been able to spend absolutely enormous sums of money out of both revenue and capital in the improvement of their properties, and the reproach can no longer lie, against the Eastern roads at all events—I did not go west of St. Paul—that they are indifferent to the safety or interests of their customers, the people.

Most railways are of the consolidated class.

9. As a result of this process of consolidation few railways exist to-day which are not controlled by some railway corporation or by a very small number of stockholders, and the large majority come under class "B." This class of railway is practically on all fours with the railways of India, the only difference being that in America private individuals or corporations have the preponderating interest in the property, while in India the Government occupies this position.

Board of Directors.

10. Whether the railway be of one class or the other its management is conducted by a Board of Directors, the members of which are men engaged in large business concerns such as banking houses, insurance corporations, trust companies, and large manufactories, as also lawyers, expert railroad

men, and wealthy capitalists, all of whom have a personal stake, and the last of whom have a vast stake, in the railways which they direct and control. In the case of the consolidated lines, those who have the preponderating interest nominate a majority of the Directors and so ensure absolute control over both policy and finances. This control is exercised wholly through the Directors placed by them on the Board, and no other agency is employed for the purpose. The Directors attend all Board meetings, which are usually held once a fortnight, and once a year travel over the line and make a complete inspection of it.

As a rule Directors are paid no fees or gratuities *qua* Directors. The appointment is regarded as an honour, and the labour and time given to it are considered to be sufficiently remunerated by the indirect benefits which come from the position. Generally speaking, the Directors of American railways are men who either have a direct and large personal interest in the companies they control, or directly represent those individuals who have a large interest. In this respect they differ from the ordinary Directors of Indian railways (as distinguished from the Government Director who is appointed by and represents the State which has a large financial interest in most Indian railways), who have not themselves a large personal stake in the undertaking, and do not represent any individual capitalist who has an immense quantity of capital directly at stake.

Once the Directors have been elected, they have absolute power over the policy and finances of the Company, save and except that they cannot increase the capital of the Company without the consent of the stockholders; and the stockholders can only interfere by the election of a new set of Directors at their next annual meeting. In practice, however, the Directors strive only to do that which will meet with the approval of their stockholders, though they do not hesitate to anticipate their approval and take responsibility between the annual meetings, when early action is desirable in the interests of the property.

In the management of the railway, the Board leaves all details to the Administrative officers, and concerns itself only with Results, with the broader questions of Policy, with proposals involving expenditure on a large scale, and with the provision of funds.

President of Railway.

11. After election the Directors meet and elect a President or a Chairman. Where the head of the Board of Directors is not a practical railroad man, he is called Chairman of the Board, and a President with the necessary qualifications is appointed for the practical management of the railway, who, however, always has a seat *ex officio* on the Board.

Where the head of the Board of Directors is a President, he is also *ex officio* the President and executive head of the railway, in which capacity he has authority in all departments, and is responsible for the general supervision and direction of all departments of the Company's service.

The President is almost without exception a railroad man who has spent the whole of his life in practical railroad operation, and is specially selected for and appointed to this position by the Directors or those who control the property, on account of this training.

Vice-Presidents.

12. In addition to the President, the Board of Directors elect *from outside their number*, that is, from outside the members elected by the stockholders, two or more expert railroad men to serve on the Board and act as Vice-Presidents, it being recognised that the business of the railway can only be efficiently managed under the control of expert railroad men.

These Vice-Presidents are called First, Second, Third and so on Vice-President, and take rank accordingly. In the absence of the President, at Board meetings the First Vice-President acts as President, and in his absence the Second Vice-President, and so on; but in the conduct of the business of the several departments each Vice-President exercises the powers of the President in his own department during the absence of the latter.

They have each charge of one or more departments of the railway according to the size and importance of the railway or the departments, and are in reality heads of departments. The distribution usually is Treasury and Accounts to one; Transportation with the allied departments, namely, Purchasing, Real Estate, and Insurance, to another; Engineering in the construction branch to another, if the work is too heavy to be placed under the Transportation Vice-President; and Traffic to another.

The Vice-Presidents are all thoroughly trained railroad men, experts in the business of the department over which they preside, and are selected because of their special fitness for the positions they fill.

Duration of office of President and Vice-Presidents.

13. The President and Vice-Presidents are appointed for one year at a time only, but their re-election is usually a matter of form. The period of office is limited, so as to make a change possible without difficulty, if it should be found desirable for any reason to remove any one of these officers. Should, however, this necessity arise when the next election is a long way off, a vote of the Board is taken, and if it required the immediate removal of the officer, he would be requested to tender his resignation, a request which a man occupying such a position would not be likely to leave unheeded. But if he did decline to resign, the Board have ample power to so curtail his duties as to render him harmless until the year expires for which he had been elected.

Standing Committees.

14. After the election of the President and Vice-Presidents, the President appoints Standing Committees varying in strength, four of whose number form a quorum, to deal with all questions relating to the road in the different branches of the business, for example, finance, transportation, including the construction and management of the railway, &c. Their duty is to report to the Board on all matters requiring its action for consideration at the next meeting.

The President and Vice-Presidents are *ex officio* members of these Standing Committees.

Questions referred to Standing Committee.

15. All matters requiring the orders of the Board are referred by the Vice-President in charge of the department concerned to the President, who, if he approves of the action proposed, refers them to the proper Committee. In practice, however, all questions of moment, whether involving expenditure outside routine matters, or relating to the policy to be pursued, or connected with the larger questions of the practical operation and management of the road, are always referred by the President to and reported upon by the Standing Committees. The great merit claimed for this system is that the demands of an individual dealt with by an individual are apt to be accepted or rejected on insufficient grounds, and that by having the Vice-Presidents members of the Committees, they can explain all matters emanating from their departments, and in person sustain their recommendations.

Advantages claimed for system.

Attitude of Board to proposals of Standing Committees.

16. There is no serious consideration of any question by the Board until the Committee has made its report, and when the report reaches it, its decision is usually expeditiously arrived at. But this does not mean that the action of the Board is perfunctory or hasty. It knows that the matters at issue have been discussed and sifted with most painstaking care in the Committees appointed to deal with them, and it does not consider it necessary to discuss again at tedious length matters already sufficiently threshed out. It recognises, when proposals from a Committee so constituted are finally laid before it, that the questions have been fully considered by experts who have a practical acquaintance with the problems submitted to them, and that the action recommended by them is that which, in their judgment, is most likely to serve the best interests of the undertaking; and, unless the confidence of the Directors had been weakened in the expert officers on the Committee through their failure to manage satisfactorily the business

entrusted to them as heads of departments, they appreciate that they cannot do otherwise than support the Committee, the members of which have a much more intimate knowledge of the affairs of the railway than can possibly be possessed by those who are not directly operating the road.

Powers of Vice-Presidents.

17. All questions not requiring to go before the Board are dealt with by the Vice-Presidents as heads of their departments, in consultation with the President when his advice is considered necessary or desirable. The greatest care is exercised in the selection of these officers, and, once they are placed in their positions, they are given a free hand, and are allowed to manage their departments without interference. They are judged entirely by Results. If these are not quite satisfactory, they are guided. If there is no improvement, they are removed from their positions.

The Vice-Presidents have power to appoint all employees, both officers and men, in their departments, and to dismiss them. They may not create new appointments requiring to be filled by officers without the sanction of the Board, but they may appoint as many employees as they consider necessary for the efficient performance of the work and fix their salaries, and are only required to obtain the approval of the President and the confirmation of the Board in a certain few specified cases, though they are expected to keep the President informed in a general way of what they are doing. There are no budget appropriations for staff. It is considered that this is not a practical way of doing business, and led to unnecessary expenditure. *Waste is controlled by the standard of test applied through Statistics. All extravagance is soon reflected in the cost of operation per unit, and the effort of everyone is directed to keeping that down, and to doing nothing which will tend to increase it.*

Throughout the service each official is permitted to appoint men to fill vacancies which occur in the staff immediately under him, subject to the approval of his immediate superior. This approval is rarely withheld, as it is recognised that the man is responsible for the work entrusted to him, that he is "responsible for the battle" as one General Manager put it to me, and that the best Results can only be obtained by giving the man the material with which he thinks he can produce them. Even where it is known that the man recommended is not the best choice that might have been made, the selection is usually allowed to stand, and the man left to learn his mistake by experience, that most valuable of all teachers.

This system might have serious drawbacks but for the fact that the standard is Results, and no one can afford to jeopardise his own position by nominating men who, in his judgment, are not *quite* suitable.

Results—definition of.

By the expression Results is meant the standard by which each man is judged. This necessarily varies with the nature of the work; but it usually is the cost of conducting the business on the basis of the particular unit selected by which to judge each kind of work. This definition does not specifically allude to that which from the Shareholders point of view is the "Results" of most importance, namely Dividends. It follows that if the income per unit is always before the Administration, and that if the cost of operation per unit is ascertained and is carefully watched and controlled, the question of profits per unit, that is, the portion of the income per unit from which the dividends are paid, is not being neglected, since they are the whole *raison d'être* for the railway.

ORGANISATION.

Mileage operated under one management restricted.

18. While there are not a few railway systems in America which directly operate a very large mileage, the length of line operated under one management is not always as great as is popularly supposed. For example, the New York Central and Hudson River Railroad controls 11,073 miles, but operates under one management no greater mileage than 3,423 miles. The Pennsylvania Railroad controls 10,536 miles, but operates under one management no more than 3,706 miles.

19. When the process of consolidation first began, these roads realised that there is a limit to the effectiveness and economy of a single management, and that railroad systems might become too large for proper and efficient control under one organisation. It was not so much a question of the length of the line to be operated as the density of the traffic. A railway passing through a sparsely settled country has comparatively little traffic, and one man could look after a greater mileage than he could possibly give efficient attention to if the country was thickly populated and the traffic was heavy.

The lines east of the Mississippi all came under the latter category, and when control was acquired of the new lines, the New York Central and Hudson River and the Pennsylvania Railroads arranged to leave them under separate organisations. These separate units have, however, themselves been growing, and the traffic over them has increased so enormously that it has only been possible to care for the increased work and duties by enlarging the number of officers and decentralising the work and elaborating the organisation. The organisation is now prescribed for the government of a trained force who well understand its distinctions and the dividing lines between the responsibilities of the various departments and the sub-divisions thereof, and appreciate that the Company's interests must not be allowed to suffer under any circumstances. Nevertheless, the growth of business has been so great, and the difficulties connected with labour unions have become so serious, that the burden, in the great Transportation Department at all events, is becoming too heavy, under the present distribution of duties, for the shoulders which have to carry it.

The subsidiary lines also, though under a separate organisation and management, require some control to be exercised over them by the parent line, and this involves the President, the Vice-Presidents, and the higher departmental officers in a good deal of labour. A breaking up of the organisation into smaller organisations is not considered to be necessary; indeed, it is believed that it would be harmful to the interests of the railway and the public. All that will be done when the time for a change arrives will be a re-arrangement of duties with further decentralisation.

Sub-division of duties on railway.

20. Under the arrangement which at present exists on the best organised railways the business is divided into departments, each under its own head, as follows:—

General Office.	Real Estate, or acquisition and care of landed property.
Legal.	Insurance.
Treasury.	Engineering.
Accounts.	Transportation.
Traffic.	
Purchasing or Stores.	

General Office.

21. *General Office.*—The President is assisted by one or more Assistants, and a Secretary to the Board of Directors.

Legal.

22. *Legal.*—This department looks after all the legal business of the Company and is directly under the President.

First Vice-President.

23. *Treasury and Accounts.*—These two departments are usually quite independent of each other.

Treasury.

The *Treasury* Department is in charge of a Treasurer who is assisted by one or more Assistant Treasurers and a Cashier. The Treasurer is the custodian of all the money and securities of the Company.

Accounts.

The *Accounts* Department is in charge of a Comptroller, who is responsible for auditing all accounts and for seeing that no expenditure is incurred without proper authority, and for generally safe-guarding the property of the Company. He is assisted by an Assistant Comptroller and by an Auditor of Freight or Goods receipts, an Auditor of Coal Freight receipts where the business in coal is sufficient to justify the appointment, an Auditor of

Passenger Receipts, and an Auditor of Disbursements, with such number of assistants as may be necessary.

Traffic.

Traffic Manager.

24. *Traffic.*—This department is in charge of an officer called the Traffic Manager, whose duty it is to procure and develop the traffic of the railway on both the coaching and goods or freight side, and to issue all tariffs. In other words, he conducts the commercial business of the railway with the public and foreign railways.

Passenger Manager. Freight Manager.

The work is never combined, as it is in India, with that of the Transportation Department, but is kept entirely separate, each department having it own organisation all down the line.

Where the work is too heavy for one man, it is divided between two, each independent of the other, who are called respectively, Passenger Traffic Manager or General Passenger Agent, and Freight Traffic Manager.

General Coal Freight Agent.

Where the goods business is too much for one man, this latter appointment is still further divided up, the whole of the Coal Traffic being dealt with by a General Coal Freight Agent, all other goods traffic continuing under the Freight Traffic Manager.

Vice President in charge.

All these officers, under the authority of the Vice-President in charge of the department, are permitted to make rates for the different kinds of traffic of which they have the management, though this power is now less wide than it was before the railway companies adopted the "community of interest" principle.

Assistants to Traffic Managers.

The Passenger Traffic Manager and the Freight Traffic Manager, whether these duties are combined in one person or not, have, to assist them,—

At Headquarters—General Agents for Passenger and Freight traffic respectively; a General Baggage Agent; and a Freight Claim Agent.

On the Line—Division Ticket Agents and Division Freight Agents, for Passenger and Freight traffic respectively, who have Districts of suitable length, and are assisted by local agents at important centres whose business is to watch the movement of and to canvass for traffic.

The Traffic officers are usually selected from members of the Operating Department and the station and goods staff who have shown a bias for this particular kind of work, as it is considered important that these officers should possess some knowledge of the incidence of the cost of transportation.

Great importance is attached to the appointments of Traffic Managers, and the greatest care is exercised in the selection of officers to fill them. The development of the business of the railway largely depends on their energy and capacity, and on some railways their appointments are regarded as of equal importance with that of the General Manager who has charge of the Transportation Department.

Purchasing.

25. *Purchasing or Stores Department.*—This department is in charge of an officer called the Purchasing Agent who has charge of all unissued stores, and is responsible for the purchase of all articles required for the Company's use, under such general instructions as he may receive from the President, the Vice-President in charge of the department, or the General Manager.

Real Estate. Real Estate Agent.

26. *Real Estate.*—This department is in charge of an officer called Real Estate Agent. He has the custody of the deeds, releases, plans and records of the real estate or landed property owned or held by the Company, and is responsible for negotiating and preparing leases of all property which the railway acquires.

Insurance.

27. *Insurance.*—This department is in charge of a Superintendent, who has charge of all matters relating to fire, marine and other insurable risks and losses, and is responsible for the inspection of all the property with reference to protection against these risks.

Engineering.

28. *Engineering.*—This department is under a Chief Engineer, who has charge of all work in connection with the building of new lines of railroad, and the construction of all extraordinary improvements to the roadbed and property, and also the construction of bridges and other important structures, including the preparation of plans, specifications and estimates in connection therewith. He is *not* charged with the

maintenance of way or repairs to stations and other structures. He is assisted by an Assistant to Chief Engineer, who, in the absence of the Chief Engineer, possesses all his powers, and is also assisted by an Engineer of Bridges, who prepares plans, estimates, and other work in connection with the construction of new bridges. These officers are located at the General Office of the Company, and are in turn represented upon the line of road, in making surveys, &c., by Assistant Engineers who are not permanently located at any one station, but carry out the plans and instructions of the Chief Engineer, and supervise the work of Contractors, &c. The work, which consists entirely of important new work, is of course inspected and its progress directed in person by the Chief Engineer and his principal assistants. The Chief Engineer has no jurisdiction over the establishments, officers and men, which look after maintenance of way and repairs.

Where the work of the department is not too heavy, the Chief Engineer is under the General Manager. Otherwise, the department is a separate one, though generally under the same Vice-President as is in charge of the Transportation Department.

Transportation.

29. *Transportation.*—I have reserved for the last the Transportation Department, as it comprises the larger portion of the working force of the railway, and on its economical administration depends to a very large extent the success or failure of the undertaking.

From the earliest times in American railway practice, it was realised that the best results could only be obtained by having one man, a General Manager, to manage and control the Operating Department in all its branches.

In distributing the work of the department, however, the three usual divisions, Engineering, Locomotive and Operating, were made, these being again sub-divided into Districts under District officers, each independent of the other. This was found to lead to a great deal of friction and lack of harmony; and, as it was soon seen that everything that was done on the District was directly or indirectly for the service of the Operating Department, the conclusion was arrived at that the only way to put a stop to friction and to secure united effort was to make the Operating officer supreme on the District, and place all other departments under him. He would then be able to control all expenditure and all work which was undertaken for the facilitating of his business. The District was, therefore, placed under a Superintendent, who was made the head of the District, the General Manager of the District, and the Maintenance of Way and Locomotive Departments were placed under him. By having all the operations in the District thus concentrated under one head, it became possible to place responsibility on the officer in charge for the careful and economical conduct of the whole business of the District in every department, and to exercise some check over the operations of the District. The District, with its Superintendent, was thus made a complete unit by itself. All expenditure of every kind in the District is charged against the Superintendent, and, as he is judged by Results, he is careful not to allow any work to be undertaken or to allow any expense to be incurred, unless he has fully satisfied himself that it cannot be done without.

Origin of District Superintendents

As the railways and their business grew, it was found that the one head, the General Manager, could not efficiently supervise and control all the Districts. A further sub-division was then made, and the line was divided into Divisions under General Superintendents, who were given charge of three or more Districts, and, under the General Manager, now supervise and control the Districts. At the same time larger discretionary powers were given to the District Superintendents.

Origin of General Superintendents.

In brief, the business of the Transportation Department is controlled by—

(i.) the General Manager, who is over all;

(ii.) General Superintendents, who control all departments in three or more Districts; and

(iii.) District Superintendents, who control all departments in one District.

Organisation.

Paras. 30—32.

General Manager.

30. The *General Manager*, under the direction of a Vice-President, is responsible for the safe and economical management of the road and machinery, including locomotives and all things appertaining thereto, and for the safe and economical transportation of the traffic. He has nothing to do with the procurement of traffic or with rates.

Departments controlled by him.

Departments not independent.

The Department (Engineering) which looks after the maintenance of way as distinguished from construction, the Locomotive or Mechanical Department, and the Operating (or what in India is generally known as the Traffic) Department, are not separate organisations, but are, as already explained, all brought together always under one man, whether at headquarters or in the Divisions or in the Districts, and, in this respect, the arrangement was more than once described to me as similar to that of an army with its Army Corps, Division and Brigade, each composed of differing elements, but each under one Commander.

General Manager's Staff.

31. For the conduct of the business at Headquarters the General Manager has as *Staff Officers* the following:—

General Superintendent of Transportation.

General Superintendent of Transportation, who, in the absence of the General Manager, acts for him. He has general charge of the train and station service, and exercises supervision generally over the handling and movement of all traffic, both coaching and goods, and the distribution of all vehicles. He is assisted, where the work is sufficiently heavy to justify it, by a Superintendent of Freight and Passenger Transportation, or by separate officers for each, who have charge respectively of the Freight and Passenger Car equipment, and all matters connected therewith, and are responsible for their distribution and for seeing that the cars are moved and loaded promptly and economically, so that they may be made to perform the fullest possible service.

General Superintendent of Motive Power.

General Superintendent of Motive Power, whose duty is to supervise and control the Motive Power or Locomotive Department in so far as may be necessary to ensure the efficiency of the equipment and adherence to the standards and systems of the railway. He is responsible for keeping a complete record of the numbers and condition of all the locomotives, cars, floating equipment and machinery owned by the railway; he supplies copies of all standard drawings, and issues instructions for the manner in which the equipment is to be constructed and repaired so as to secure adherence to the standards; and he has charge of all tests and experiments.

Chief Engineer of Maintenance.

Chief Engineer of Maintenance of Way, whose duty is to generally supervise the Maintenance of Way Department. He is also responsible for the preparation of Maintenance of Way plans for adoption as standard.

Engineer of Maintenance.

He is assisted by an *Engineer of Maintenance of Way* who has direct charge and control of the Maintenance of Way Department in so far as may be necessary to ensure the efficiency of the department and adherence to the standards of the railway. He is responsible for the preparation of all Maintenance of Way plans, and for the supply of standard drawings to the Divisional officers, and for the issue of such instructions as may be necessary to ensure adherence thereto. He is also responsible for the thorough inspection in person of all bridges and other structures.

Superintendent of Telegraphs.

Superintendent of Telegraph, whose duty is to generally supervise the construction and maintenance of all telegraph and telephone lines owned or operated by the railway in so far as may be necessary to ensure the efficiency of the service and adherence to the standards and systems of the Company.

Divisions of railway.

32. As explained in paragraph 29, for the proper and efficient management of the service, it was found necessary to divide up the railway into two or more Divisions under General Superintendents, and to divide these again into Districts under Superintendents.

General Superintendent.

33. *The General Superintendent* is responsible for the maintenance of the track, for the proper discipline of the employees of his Division, for the safe and economical movement of the passenger and goods traffic, and for the maintenance of the service at the proper standard of efficiency. He has nothing to do with the procurement of traffic or with rates. He has charge of all the landed and personal property of the railway on his Division, including the shops, stations, and other buildings, the telegraph lines, the locomotives, rolling stock, and all other property connected with the business of the railway; and he forwards direct to the Auditor of Disbursements all bills for expenses and all pay rolls when certified by the employing officer. In other words he is General Manager of his Division.

General Superintendent's Staff.

34. To help him in the management of his division the General Superintendent has as *Staff Officers*—

Principal Assistant Engineer.

A Principal Assistant Engineer who assists him in all matters pertaining to maintenance of way, and

Superintendent of Motive Power.

Master Mechanic.

A Superintendent of Motive Power, who has charge of all locomotive and car shops, and of the maintenance and repair of the locomotives, rolling-stock, tools and machinery in the Division, and is assisted at each engine station where machinery is maintained by a *Master Mechanic*. He is authorised to communicate directly with the Master Mechanic on all matters relating to the mechanical execution of the work, but is required to communicate through the District Superintendent concerned all orders referring to the discipline of the shops, the increase or decrease of the force, or changes in the rates of wages.

District Superintendent.

35. The *District Superintendent* exercises on his District all the powers of the General Superintendent which may be necessary for the proper management of his District, and is responsible to the General Superintendent for the maintenance of the track, bridges and buildings, the speedy and economical loading of the traffic, the safe, speedy, and economical movement of the traffic, and the proper transaction of the business generally of the District. He has nothing to do with the procurement of traffic or with rates.

District Superintendent's Staff.

All the staff of all branches of the Transportation Department on the District are under his control, and for the management of them he is allowed—

District Engineer.

(*a*) *A District Engineer or Road Master*, who has special charge of the maintenance of the road bed, culverts, bridges, tracks and buildings, and all other matters pertaining to maintenance of way. He usually has nothing to do with important construction work. This is attended to by the Engineering Department.

The District Engineer or Road Master has under him Supervisors, Assistant Supervisors, Track Foremen, and Trackmen for the roadbed; a Supervisor of Signals, Foremen, Repairmen, Lampmen, &c., for the care of the signals; and a Master Carpenter, Foremen and Carpenters for all woodwork.

Passenger Train Master.

(*b*) *Passenger Train Masters* who attend to all business connected with the movement of the passenger traffic over their sub-divisions, and have charge of the Station Masters, and the Passenger Guards, Brakesmen, and Baggage men.

Freight Train Maste

(*c*) *Freight Train Masters*, who attend to all business connected with the movement of the goods traffic over their sub-divisions, and have charge of the Yard Masters, Shunters, and Goods Guards and Brakesmen.

Train Despatcher.

(*d*) *Chief Train Despatcher*, who regulates the movements of all trains on the District and has charge of the Section Train Despatchers and the Telegraph operators and repairmen.

Road Foreman of Engines.

(*e*) *Road Foremen of Engines*, who have charge of the Enginemen and Foremen and their engines while on duty, and are responsible for seeing that the engines are not abused or neglected by the enginemen while in use, and that they are economically operated.

Master Mechanic.

(*f*) *Master Mechanic*, who has charge of all the Shops and the Round Houses or Engine Sheds on the District, with the mechanics, &c., employed therein. He is assisted by a Foreman of Engine repairs, and a Foreman of Car repairs.

Station Agents.

NOTE.—The Station Agents, that is, the men who are responsible for the collection of the revenue in the coaching and goods departments, are also under the direction of the District Superintendent, but are controlled by a specially assigned officer, who is generally an Assistant Traffic Manager.

Assistant District Superintendent.

36. *Assistant District Superintendents.*—Where the District has become too large for proper management by one man and it is not considered desirable to break it up, the District Superintendent is left in direct charge of the Main Line only, and is given an Assistant District Superintendent, under whom are placed all branches in the District, over which he exercises, subject to the control of the District Superintendent, all the power and authority which the District Superintendent exercises over the District.

MANAGEMENT.

General Manager's personal control limited with large lines.

Difficulty met by appointment of General Superintendents, and by Statistics, and Inspection.

37. With railways extending to the length they now do under one management, it was obvious that the General Manager could no longer continue a detailed personal supervision of the department he controlled. It was also obvious that he could no longer give personal attention to every detail of that department. The difficulty in the latter respect could be, and was overcome by the introduction of General Superintendents, and by giving them and Superintendents large discretionary powers. It was not, however, possible for the General Manager to transfer the personal supervision into other hands and yet exercise proper control of the department for the efficient operation of which he was responsible.

A system of Statistics had been gradually growing up, and it was soon seen that, with each District a complete unit, an adequate check might be exercised through Statistics, supplemented by such personal inspection of the railway as the General Manager could spare time for, or as was found to be necessary. The Statistics were accordingly elaborated, and by means of them it is possible for the controlling officers now to ascertain where weakness of management exists, and then to apply the necessary personal supervision to that unit. The method adopted is explained in Chapter II.

While, however, Statistics might be used for the exercise of control over the operation of the railroad, they could not be used to show how the maintenance of the road bed, bridges, &c., was being done. To ensure proper supervision over these, an organised system of inspection was introduced, which will be explained later.

Success secured by Organisation and Personnel.

All officers allowed to run without excessive interference.

38. Success is further secured by Organisation and Personnel, and by the careful selection of officers. Once they have been selected, officers in every grade, from the President downwards, I might almost say employees of every grade, are allowed to conduct their business with as little interference as is possible. Everyone is believed to be honest until he has proved himself to be dishonest, and everyone is trusted until he has shown himself to be unworthy of confidence. All are judged by Results. If these are not satisfactory, they are guided, and if there is still no improvement, they are changed.

In giving these discretionary powers to officers, the policy was stated by a high official to be "Do what you please, but get the Results and don't make too many mistakes. That is the policy. Hands off everyone. Put the load on the man, and change him if he is unsuitable."

Policy has proved satisfactory.

39. It was the policy I found being pursued everywhere, with the most satisfactory results. As a consequence of the confidence placed in them, men were not afraid to take responsibility, and they all seemed imbued with a sense of their own powers. They were not haunted by the fear of this or that regulation, or the knowledge that someone was on the look out to trip them up. They did their duty fearlessly, striving to secure what, in their judgment, seemed to be the best Results for their employers, and knowing that if they did sometimes make a mistake, allowance would be made for errors of judgment.

Men changed when not suitable.

40. The principle of changing men who prove unsuitable for their positions is not a theoretical one. While I was in America, the President of one large system was changed because his Results had not been quite satisfactory, and I heard of several cases of the higher officers being removed from their positions because their responsibilities had grown too great for them, or they were no longer physically equal to the strain of them. The railway is being worked for a profit, and it is recognised that in these days of keen competition, dividends can only be obtained or maintained by employing the best man procurable to control and manage the great departments of the business. Anyone who fails to keep pace with his increasing responsibilities is not long retained in his position. In removing men, however, from their appointments, a great deal of consideration is shown them. If the failure is not due to causes which the man could have controlled and has been the result of his place having become too big for him, if he is an old servant, some other appointment is found *or made* for him, as the Company consider that his experience and knowledge have a value and are worth retaining.

Much consideration shown in such cases of failure.

Men of high attainments sought for.

Such men rise quickly, and knowledge that this is so, encourages all.

Claims of seniority not ignored but fitness is standard.

Age not allowed to affect selection.

41. To conduct the business of the several departments in the different grades under present conditions in America, men of high attainments are necessary, and a close watch is always kept on all the employees to find men of education, ability, energy, and steadiness of character. Where such men are found they are not slow in rising, and the fact that every man feels that his advancement depends on his own personal efforts acts as an incentive to all to do their best. In advancing men, the claims of seniority are not ignored, but the chief and almost the only claim to advancement is suitability for the position to be filled. Considerations of age are never allowed to affect the selection, and I found General Managers of large systems men under 35 years old, and I met Presidents and Vice-Presidents who had attained their positions at that age, the view held being that a bright, energetic, intelligent, ambitious man would bring the concern in the way of business or save it by economical and intelligent management, a great deal more than he would lose it by a deficiency of age as reckoned by years.

All employees required to begin at bottom.

No exception made in case of College men.

42. All employees of whatever class, whether they have received a College or a Technical education or not, are required to begin at the very beginning. Civil Engineers, who are graduates of Colleges, have to begin as rodmen, or as trackmen, and are kept in that position till they show fitness, before they are advanced to Assistant Supervisor, which is the lowest position of authority. Mechanical engineers, who are College graduates, have similarly to go through the mill in the Locomotive Department.

Operating Department same practice followed.

43. It is the same in the Operating Department. Anyone desiring employment in the superior grades, whether he be a College graduate or not, has to begin at the bottom rung of the ladder and prove his fitness before he is advanced.

Management.

Paras. 44—48.

All officers thus men who have gone through the ranks. Standing Committee system prevails. All thus obtain some knowledge of each other's work.

44. The District Engineers, Master Mechanics, Road Foremen of Engines, Train Despatchers, and Train Masters are thus all men who have had a practical training in their business before they have reached their positions. They all serve under a common head, the District Superintendent. The Standing Committee system is extended right down to the business of the District, all questions of moment being discussed by the officers on the District at a meeting. In this way the District Superintendent is supported by the experience and advice of the men who are actually carrying out the operations, and the officers themselves get to have some acquaintance with each other's business.

District Superintendents not chosen from one branch of service, so as to give all something to strive for. Educational system gives all men a fair grounding, and Colleges teach railroad subjects.

45. In the selection of officers for the position of District Superintendents, the choice is not confined to any particular branch of the service, but the man who is likely to prove most suitable is appointed. Effort is made, however, to promote men from every branch of the business, so that every man may feel that the road is open to him to be an Official. Seeing one of their class an Official, stimulates all men in the same branch to improve themselves and to strive for the higher position, and raises the general standard of the service.

With the excellent system of education which obtains for the lower classes, all men start with a fair grounding, and those who are ambitious to rise continue their studies and their general reading, so that by the time the position is ready for them they may be educationally well equipped for the position, as the necessity for men of education in positions of responsibility is recognised by the men as much as by those who control the railway. Indeed the importance of the Railroad profession is so strongly felt now in America, that all the principal Colleges in the country give instruction in the science of Railroad Organisation, Operation and Mangement; Railway Economics; railroad problems in general; and in the principles governing the rates charged for Railway service. I was permitted to attend one of these lectures, delivered by Professor Allen to the students at the Massachusetts Institute of Technology in Boston. The questions had, as Professor Allen explained to me, necessarily to be dealt with in a somewhat rudimentary way, but all the students, who were going to make railroads their profession, left the College with some knowledge of the great problems which would confront them, and many of them left equipped with an intelligent appreciation of their theory. The value of this training cannot be over estimated, and railways are not slow to take on and practically train young men who give evidence of aptitude for railway administration.

No difficulty from District Superintendents having no technical training.

46. No difficulty is experienced from having as District Superintendents men who have had no Civil or Mechanical Engineering training and a large number of these appointments are filled from men trained in the Operating Department alone.

Engineers considered by many unsuitable for District Superintendents.

47. On the other hand I was informed by more than one President, that Civil Engineers do not as a rule make good District Superintendents, as they rarely combine an aptitude for business with their scientific training, and, having had the spending of large sums, are not always economical. Most of the scientific work is done by the Corps of Engineers, who are not brought into such close relations with the Operating department, and the District Engineers or Road Masters are often men who have themselves had no scientific training.

Those met were all good men.

48. I met several Engineers in the position of District Superintendents, and, so far as their knowledge of their work went, they appeared to me as good as those who were not Civil Engineers. I also met Engineers filling the position of General Manager and President; but Engineers are never

selected for these positions unless they have been through the Operating Department, and have previously held charge of Districts in that Department.

It is not the branch a man belongs to which gets him office but he himself.

49. The fact is, and this was often said to me, it is not the branch of business in which a man is trained which qualifies him for high office, but the individual himself, and all officers are chosen by the one standard alone, fitness and their ability to fill the appointment with benefit to the Company.

Districts—length of.

50. As previously stated, the unit is the District Superintendent's charge. The length of a District varies according to the nature of the country traversed, the density of the traffic, and the number of stations of importance. It is as long as 500 miles, and it consists of as few as one station, a terminal. There is no fixed rule. Circumstances entirely govern the settlement of the question.

Salaries of District Superintendents.

51. The salaries of District Superintendents vary from $200 or Rs. 600 to $500 or Rs. 1,500 a month. In addition, they are supplied with houses free of rent, and are allowed one coloured servant at the expense of the Company.

District Engineer or Road Master and Supervisors.

District Engineers or Road Masters receive from $150 or Rs. 450 to $185 or Rs. 555 a month, and Supervisors $110 or Rs. 330 a month, and are usually, but not always, supplied with quarters free also.

General Superintendents.

General Superintendents receive $600 or Rs. 1,800 a month, and free quarters, and are supplied with two coloured male servants at the expense of the Company.

The salaries of the higher officers vary:

President.

The President on many roads receives as much as 10,000*l.* a year from the road he directly operates, and as much more from all the other roads which he controls.

Vice-Presidents.

The Vice-Presidents from $800, to $1,500 or from Rs. 2,400 to Rs. 4,500 a month;

General Manager.

The General Manager from $1,000 or Rs. 3,000 a month and upwards;

Traffic Manager.

The Traffic Manager from $1,000 or Rs. 3,000 a month and upwards;

Gen. Supdt. Transportation.

The General Superintendent of Transportation from $800 or Rs. 2,400 a month and upwards;

Chief Engineer.

The Chief Engineer from $500 or Rs. 1,500 a month and upwards;

Supdt. Motive Power.

The Superintendent of Motive Power from $600 or Rs. 1,800 a month and upwards;

Comptroller.

The Comptroller from $750 or Rs. 2,250 a month and upwards.

Travelling Allowance.

52. No fixed travelling allowance is paid. Those officers who are allowed private cars have them entirely equipped by the Company, and all food, smokes and drinks are provided at the expense of the Company. Those officials who have not the privilege of private cars have all their expenses while on tour, such as hotel and restaurant bills, cab fares, &c., refunded to them.

All expenses paid by Company.

INSPECTION OF RAILWAY.

Inspection of property.

53. In paragraph 37, I said the necessary control over the maintenance of the roadbed, &c., was exercised by an organised system of inspection.

Inspections held.

These inspections* are held—

(i.) Annually by the Board of Directors.
(ii.) Annually by the General Manager.
iii.) Monthly by the District Officers.

Prizes awarded.

After the two latter inspections, prizes are awarded, which are announced at the conclusion of the inspection by the Board of Directors.

The object of these inspections is the betterment of the condition of the property generally; and the object of the prizes is to stimulate competition on the part of the supervisors and track foremen, and so ensure the road being kept up to a higher standard of efficiency throughout the year than could be obtained by any other means.

Monthly inspections.

54. The monthly track inspection is made by a Committee composed of the Engineer of Maintenance of Way, and one Superintendent from each General Superintendent's Division. It embraces only the main line, and the Superintendents on the Committee are selected from the Branch Districts and not from the Districts of the main line. The Committee cover the territory to be inspected on a special car attached to one of the regular speed trains. They note and take record of mechanical tests and observations of the condition and riding of the track of each Supervisor's sub-division, and, at the close of the inspection year, which is October, prizes are awarded on a basis of the best average throughout the year, as follows:—

Prizes awarded.

The Supervisor and his Assistant who maintain the best track on the main line in each General Superintendent's Division *throughout the year*, that is, who have the highest number of marks at the end of the year, are awarded $700 and $500, or Rs. 2,100 and Rs. 1,500, respectively. In addition to this, and on the same basis, prizes of $500 and $300, or Rs. 1,500 and Rs. 900, are awarded to the Supervisor and Assistant Supervisor of each Superintendent's District for the best track on the District during the same period. A man receiving the former prize, is not eligible for the latter.

Annual inspection.

55. In October of each year, after the ordinary renewals and repairs have been made, and the track, road-bed, bridges, buildings, telegraph line, &c., have been put in the best possible condition that circumstances will permit, an annual inspection is made of the main line by the General Manager, who is accompanied by—

General Superintendent Transportation.
General Superintendents.
District Superintendents.
Chief of Motive Power.
General Superintendent Motive Power.
Superintendents of Motive Power.
Superintendent, Freight and Passenger Transportation.
General Agents.
Superintendent of Telegraph.
District Operators.
Chief Engineer.
Engineer of Construction.
Chief Engineer Maintenance of Way.
Assistant to Chief Engineer.
Principal Assistant Engineers.
Assistant Principal Assistant Engineers.
Engineer of Branch Lines.
Engineer of Maintenance of Way.
Engineer of Bridges.
Engineer of Tests.
Assistant Engineers.
Supervisors.
Assistant Supervisors.
Engineer of Signals.
Invited Guests.

The party is accommodated in five trains, each composed, first, of a specially designed observation or inspection car; second, the engine; third, a special car; fourth and rear, an observation or inspection car similar to the one in front of the engine. These trains are run at a speed of from 20 to 30 miles per hour, one day being consumed in the inspection of each Superintendent's District.

* The system described is that which obtains on the Pennsylvania Railroad.

The party is divided into five Committees, each person being furnished with a card on which to record the different features. Committee No. 1 mark on Line and Surface; Committee No. 2, on Freight Tracks and Sidings, and Frogs and Switches; Committee No. 3, on Joints, Spacing of Sleepers and Ballast; Committee No. 4, Road Crossings, Station Grounds, Policing and Ditching; and Committee No. 5, Telegraph Lines, Fixed Signals, &c. Committees formed who judge for different things.

The marks of merit range from one to ten, ten denoting perfect condition, five, medium, and one, very bad. Intermediate numbers denote intermediate conditions, and a cross (×) denotes the absence of a feature.

These cards are distributed before each day's start, and collected at the end of each Superintendent's District, and sent to the General Superintendent's Office, where the total and average are arrived at as a basis for the awarding of the following prizes:—

Prizes awarded.

1st. General Manager's prize of $150 or Rs. 450 to the best Supervisor's charge, and $75 or Rs. 225 for the next best Supervisor's charge; $100 or Rs. 300 to the Track Foreman having the best Yard; and $75 or Rs. 225 to the Track Foreman having the best Foreman's section. These prizes are only awarded for the sections on the main line.

2nd. Superintendent's prize of $100 or Rs. 300 is awarded to the Supervisor having the best Supervisor's charge; $50 or Rs. 150 to the Track Foreman having the best Foreman's section on each Superintendent's District; and $50 or Rs. 150 to the Track Foreman having the best section on each Supervisor's Sub-Division.

The District Superintendent's prizes cover his own District only and are based on the highest average at the time of the Annual Inspection.

Inspection of branches.

After the Inspection of the Main Line, the Branches are inspected by a small party, made up of the District Officers accommodated in one train, and prizes of $50 or Rs. 150 are awarded for the best Track Foreman's section on each Superintendent's District.

Date and direction not made public too soon.

The date or direction of the Annual Track Inspection is not announced until about one month in advance, so as to prevent Supervisors from confining their entire sub-division forces to tracks governing the direction of the inspection only, and to ensure their work covering track in both directions, as is desired.

APPOINTMENTS, TRAINING, AND DISCIPLINE.

Appointments—Rules governing.

56. Every employee on appointment is required to be below a certain age (the age varies—on some railways it is 26, on others as high as 35), and he must pass a medical examination before he can be admitted into the service. He is also required to produce evidence of reasonable education and intelligence and of good moral character. Men addicted to drinking are never employed, and are not retained long in the service if they develop the habit after joining.

Men handling money give bonds.

57. All men holding positions which place them in the way of receiving money on behalf of the railway are required to give bonds of varying amount, which increase in value as they rise in the service.

In the case of station employees the Station Agent is bonded to the railway, and all men under him are bonded to him.

Companies are formed in America who give the necessary security for the employee. They receive payment from him for the accommodation, and employ detectives to keep a watch on the men to see that they are running straight. This system has been found to be in every way an excellent one.

Appointment, Training, and Discipline.

Paras. 58—61.

All required to devote all their time to Company.

58. Each officer, agent, and employee in each department is required to give his whole time and attention to the duties assigned to him, to use every exertion to secure the best Results in his operations, to secure increase in the traffic, to conduct his business in the most economical and efficient manner, and, whenever any circumstances may come to his notice that he may deem to be advantageous or detrimental to the interests of the Company, whether in his own department or elsewhere, to immediately report the same to the head of his department, for report, if considered proper by that officer, to the General Manager or to the President. Ignorance is not accepted as an excuse for neglect or omission of duty. Each employee is expected to become conversant with his duties, and with the procedure governing the same.

Ignorance no excuse.

Sight tests.

Williams' lantern test for colour blindness Appendix A.

59. Men for employment in the Train service, where sight and hearing are important, are very carefully tested for colour blindness and hearing. To ensure reliability of test of sight and to prevent partiality, Dr. C. H. Williams, of Boston, Mass., who was at the time Chief Medical Director of the Burlington Railroad, has invented a very ingenious lantern for the test of sight for colour blindness by night, a description of which will be found in Appendix A., and has devised a system of worsted tests based on Professor Holmgren's system for the test of the sight for colour blindness by day. He has also devised a system of type cards for the test of the sight generally.

Williams' system valuable.

Dr. Williams showed me the whole system in operation, and I was much impressed with the value of it. His lantern is procurable from Messrs. Peter Gray & Sons, 88–90, Union Street, Boston, Mass., price $20 or Rs. 60; his Standard Test Types for determining the acuteness of vision, from the Rand Avery Supply Co., Boston, Mass.; and his "tagged set of Holmgren's worsted," with instructions for their use, from Andrew J. Lloyd & Co., 323, Washington Street, Boston, Mass.

Training and advancement.

60. After appointment, men who have had no previous experience are trained. Those employed in the Train service, that is, firemen, enginemen, brakesmen, and conductors, are required to pass an examination in their duties, and in the rules governing their work, before they are confirmed in their appointment or are promoted, and all appointments and promotions are governed strictly by the date the examination is passed. A number of questions are printed with the copy of the Rules supplied to the District Superintendents so as to facilitate the examination of candidates in the rules and to secure uniformity of standard on the different districts.

In all other branches of the service the employee's fitness for promotion is determined by his superior.

Discipline.

Fines discontinued.

Black marks given for ordinary offences.

61. Punishment by fine has been almost entirely discontinued in America. It is held to be not right to deprive a man of pay for work done; in other words, to benefit the Company at the expense of the man. Where the offence is not of too serious a nature, a man is reprimanded, and a black mark placed against him, which is posted up on a notice board for all to see. These black marks affect his promotion, but can be wiped out by any subsequent action calling for special commendation.

Suspension for serious offences.

Where the offence is serious, and a reprimand is held inadequate, the man is suspended from duty without pay for a definite period, another man being put on to take his place.

Dismissal.

Where neither reprimand nor suspension is held to be adequate punishment, or the man is an old offender, he is dismissed the service.

Punishments usually decided by Committee.

As a general rule no punishment of any kind is inflicted on the train staff without the offence being investigated by a committee of officers, who recommend to the District Superintendent the nature of the punishment to be inflicted.

The employee punished has the right of appeal to the District Superintendent, and from his decision to the next officer, and so on, and may send this appeal *direct*. Right of direct appeal recognised.

The effect of this system is generally recognised to have been most beneficial. The men now are as anxious to avoid a reprimand as before they were to avoid suspension, and the general tone of the service has been much improved. System has proved beneficial.

CORRESPONDENCE.

62. *Correspondence* between officials is discouraged. All the details are required to be thrashed out at personal interviews and meetings, and where a record of the proceedings or a letter is necessary the bare facts are stated as briefly as possible. Correspondence discouraged.

In the case of Engineering Works involving expenditure, the Engineer of the Construction Department prepares the plans and estimates after the work has been decided upon, and submits them in triplicate to the Chief Engineer, with a very brief note to explain the nature of the work and its cost, and a still more brief note to explain the reason for it, and attaches such correspondence as may have passed. Estimates for expenditure. Procedure followed.

The Chief Engineer revises the proposal if necessary, and passes it on to the General Superintendent, who endorses and passes it on to the General Manager, who similarly only signs it, retaining one copy for record in his office. The papers are then taken by the General Manager to the Vice-President and the proposal discussed with him. If the Vice-President accepts it, he initials the Chief Engineer's Report, often in pencil. His office then gives a number to the sanction, and takes a note in a register of the work to be done and the amount. (A similar register is kept in the General Manager's office.) No other record is kept in his office. Authority is then conveyed by the General Manager for the work to be put in hand, and the proposal itself is passed on in original to the Vice-President in charge of Accounts, who advises the District Superintendent to what head of account the work is to be charged.

On the bills for the work the Vice-President's authority number is quoted, and a record kept in the Audit office of all expenditure against that sanction. When the work is completed, the District Superintendent notifies the Auditor, who then summarises the bills and submits monthly a statement to the Vice-President and General Manager of all works completed during the month, who enter in their registers the actual cost. If the estimate has been exceeded, enquiry is made as to the cause.

If the proposed work involves large expenditure, the Vice-President passes on the proposal to the President, who refers it to the Standing Committee. If that Committee decide that the work is necessary, it considers whether the work shall be paid for out of revenue or be charged to capital.

Everthing is charged to operating expenses that can possibly be so charged without lowering the rate of dividends. Apart from other reasons for this, the possibility of the expenditure being charged to operating expenses, and consequently affecting the Results of the District, makes the District Superintendent slow to recommend expenditure, unless he feels he cannot get along without it or he is satisfied that it will result in reducing the cost of operation.

If the work is to be charged to capital, the proposal is referred to the Finance Standing Committee which decides how the money is to be provided. Once it is admitted that a work is necessary for the economical conduct of business, the cost of it is usually regarded as a matter of quite secondary importance.

As a rule the Maintenance of Way Staff only undertake small construction works, but each case is considered, and the Vice-President and General Manager decide by whom the work shall be done.

If it is not to be done by the Road staff, the work is usually done by contract, it being found cheaper to do such work by contract than by a force employed by the railway. Where a Contractor is employed, an Engineer is placed in charge of the work to see that specifications are adhered to.

The same procedure, *mutatis mutandis*, is followed in regard to all expenditure on works or equipment.

Stenographers used by all.

Advantages of them.

63. Every officer has a Stenographer, or shorthand writer, the higher officers more than one, and in every office there are one or more for the use of the clerks who are responsible for the preparation of letters, &c. It is quite rare for anyone to write a communication with his own hand. The saving of time in which this practice results is enormous; but, what is much more important, the physical relief is incalculable. It is the combination of the mental and physical effort which is so exhausting; and many men break down and loathe the sight of work not so much because of the mental strain, as on account of the labour of writing.

In every branch of business in America the great value of Stenographers is so fully appreciated that everyone uses them always.

Typewriters extensively used.

64. The Stenographers are always Typists as well, and do their transcribing straight on the typewriter. This again saves a great deal of time, to say nothing of the eyesight. It is quite unusual to receive a business communication in manuscript. Even books are entered up directly with typewriters. Copies of documents are not usually taken with carbon paper as this delays the Typist in his (or her) work; but are taken off on tissue paper in a machine, to which I shall refer later when dealing with the question of labour saving devices.

Telephones extensively used.

65. To further facilitate business, there is a telephone on the table of every officer, and on the tables of the more important clerks. It is thus possible for questions to be discussed without the officer leaving his desk. The conversation may be with an officer not two rooms off, or it may be with some one in the same town or in a town hundreds of miles away.

All kinds of questions settled on them.

Questions of the greatest importance are so discussed, not only by railroad men among themselves, but by business men of all walks in life. Orders so given or received, or arrangements so made, are never disputed. There is not the same anxiety to put everything in writing as exists in India. As much as can be arranged verbally or through the telephone is so arranged, and where there has been a misunderstanding and the error which results is not wilful, every allowance is made for it.

Cost great but saving of time greater.

The cost of providing all these telephones is, of course, great, though the rental of an individual telephone is only $7-50 or Rs. 22.8 a year, but this is regarded as more than compensated for by the enormous saving of time and the consequent expedition of work.

Telephones not confined to controlling offices; every station has one.

The supply of telephones is not confined to the controlling offices, but every station and each office at large stations has one or more of them. In hotels *every room* has one. No tradesman or private house of any standing is without one, and there are public telephones at short intervals all over the towns and cities.

India uses neither telephone nor stenographer to any extent.

66. In India, the Stenographer is regarded as a luxury and the Telephone as an extravagance, and both these very valuable aids to business are almost conspicuous by their absence. In the Imperial Secretariat in Calcutta, where the departments of the Government of India are collected, I think I am right in saying there was only one telephone in the whole building. In Simla there was not one in the Public Works Secretariat, and I don't think there was one in the offices of any of the other departments, scattered though these buildings are all over the hill sides. Stenographers are equally scarce,

and I doubt if more than three men could be found in all the Government of India offices, and they are not employed because they are stenographers.

In America on every side the remark was made that it would not be possible to conduct business without telephones and stenographers. It certainly could not be conducted as efficiently or as expeditiously, or with as little wear and tear to the individual.

America could not get on without them.

67. To so great an extent is the principle of saving physical effort carried, that the signing of letters on all routine matters with rubber stamps is freely permitted, and the signatures of unimportant documents in pencil is not forbidden.

Letters signed with rubber stamps.

Extraordinary as it may seem, the confidence placed in the good faith of the men engaged in railroad operations is very great; and the mutual trust is still greater. It is recognised that the best Results can only be obtained by allowing every man to run on his own feet. Mistakes are expected, but even if precautions could prevent them, the taking of these precautions is considered to destroy individuality, and to deprive the employer of the man's best efforts.

Mutual trust general. Mistakes expected. Precautions destructive of individuality.

Under the system pursued, each man does his very best unrestrained, and is always striving to bring himself to notice either by suggestions tending to improvement or economy, or by showing good Results, or both. This and the system of advancing men by merit, are responsible for the highly intelligent service to be found to-day in the railroad profession in America.

System followed leads to all striving for best Results.

68. It would be idle to say there is never friction between departmental officers, but there is a strong *esprit de corps* on all railways, and all employees are trained to recognise that the interests of the Company are paramount, and that these cannot be best served where there is lack of harmony. There is consequently very little friction; but when it does occur, it is put down with a strong hand.

Friction not absent but very limited.

ASSOCIATIONS.

69. Closely connected with the management of American railways are the numerous Associations of Railroad Officers. Every conceivable branch of the business has its Association. To enumerate them all would fill up pages of my report. The most important of them are the following, and of these only the first four are official. All the rest are what might be called private associations:—

Associations of officers of all branches of the business.

Most important enumerated. Only four are official, rest are private.

The American Railway Association.
Official Classification Committee.
Western Classification Committee.
Southern Classification Committee.
The American Society of Railroad Superintendents.
Association of American Railway Accounting Officers.
International Association of Car Accountants and Car Service Officers.
Railway Transportation Association.
Train Despatchers' Association of America.
The American Association of General Passenger and Ticket Agents.
The American Association of General Baggage Agents.
The American Railway Engineering and Maintenance of Way Association.
Road Masters and Maintenance of Way Association.
The American Railway Master Mechanics' Association.
The Master Car Builders' Association.

American Railway Association.

70. The American Railway Association is comprised of railways in their corporate capacity.

Object of it.

"Its object is the discussion and recommendation (I am quoting from the Articles of Association) of methods for the management and operation of American railways.

Action only recommendatory.

"Its action shall be recommendatory and not be binding upon any member."

Constitution.

Each company is eligible to one "membership" only, unless the aggregate mileage it operates exceeds 1,000 miles, in which case it is allowed an additional membership for each extra 1,000 miles.

Voting powers.

"Each membership is entitled to one vote, which vote shall be cast only by an official of the member voting."

Officers of Association.

"Its officers consist of a President, a First and Second Vice-President, and a Secretary and Treasurer. The President and Vice-Presidents must be officers of companies, members of the Association, ... and are members of the Executive Committee. The term of each of these officers is one year."

The articles may not be amended except by a four-fifths vote of the members present, and then only after such amendment has been proposed at one regular session for consideration at the next regular session.

The Association holds two meetings a year.

Standing Committees.

The by-laws require that the organisation of the Association shall include the following Standing Committees :—

An Executive Committee, nine members, including the President and the Vice-Presidents.
A Committee on Train Rules, nine members.
" " Car Service, nine members.
" " Safety Appliances, nine members.
" " Nominations, five members.

Association really one of Transportation Officers.

The Association is really a meeting of Transportation officers, and each railway is represented usually by an officer of that department.

Action not binding.

As the Articles of Association show, the action of the American Railway Association is only recommendatory and not binding on any member, and it is due to this fact, I was told, that the success of the Association is largely due.

But recommendations rarely neglected.

But while this is the legal position, in practice it is very exceptional for the recommendations of this body to be ignored by any railway. Where any doubt is felt as to the wisdom of a recommendation, the Association are asked to reconsider it; but it is rarely necessary to do this, as every member has the opportunity to obtain all the advice he needs in the intervals between the meetings. The members are all trusted representatives of the several railways. They are deliberate in their consideration of all questions, as a reference to their proceedings will show, and never commit themselves to an opinion or venture on a recommendation, until the question has been thrashed out in Committee first, and afterwards at a regular meeting of the Association. As a consequence, their opinions command respect, and no railway feels justified in setting its individual opinion against the collective judgment of so large and influential a body.

Very good work done by Association.

The Association has done a very great deal to harmonise the practice in all essential matters on all railways; it is a great power for good in the American railway world, and has been of great assistance to the Government on more occasions than one.

Classification Committees also official.

71. The Classification Committees are associations of Freight Traffic Managers whose duties and functions will be explained in the chapter on Goods Rates.

All other associations private, but encouraged and helped by railways.

72. All the other Associations, while not official, are recognised by the railways. On most railways their men are encouraged to join and their membership fees paid. The opinions of these Associations are held in respect, and the different bodies are often consulted by the American Railway Association.

A great deal of very valuable work has been done by these outside associations apart from the great benefit the men themselves derive by constantly meeting men working in the same field. The uniform standards for equipment were largely the work of the Master Car Builders Association, and the present "per diem" rates for rolling-stock going on to foreign railways are the outcome of the labours of the International Car Accountants and Car Service Officers.

Much good work done by these outside associations.

73. As I previously remarked, a great deal of work in America is done in Committee, on the principle, no doubt that, "in the multitude of councillors there is safety"; and where men who are experts (and none but men who are experts in their respective branches are employed. Square men are not kept in round holes, or round men in square holes) form an opinion which has the support of the majority, the feeling is that it will generally be wise to accept it.

Value of Committee work recognised in America.

CHAPTER II.

STATISTICS.

Control of American Railways exercised through Statistics.

74. One of the subjects which had exercised my mind a good deal before I went to America was how the large undertakings now operated under one organisation were managed and controlled, since personal supervision by the higher officers was no longer practicable. I asked the question of several Presidents, Vice Presidents, Heads of Departments and District Officers whom I met. Without exception they gave me the answer that the control was exercised through Statistics. Equally without exception, they said they could not possibly conduct their business efficiently without Statistics; that without them they were working in the dark; and that they could not understand how any railroad could be efficiently and economically operated without Statistics.

Reasons which led to Statistics.

75. The President of the railway which has made the most scientific study of the subject, told me that at one time his railway kept only the most meagre Statistics. Beyond knowing in a general way that he ran so many train miles and carried so many passengers and so many tons of goods, and that he earned so much revenue and expended so much money in the service, he had no information. He had no means of knowing what the income from any particular service was, nor had he then any idea of the cost of providing it. He had no standards of any kind to guide him. He felt this was not right, and that if he was to operate his railway economically and with profit, he must know exactly where the money went, and what income was being received in return for a particular expenditure. He accordingly proceeded to devise some form of Statistics which would give him the necessary information, and, after many trials and errors, he arrived at his present system. It is elaborate, amazing in its elaboration when compared with the Statistics maintained in India, and involves a good deal of expenditure when the amount is gauged merely by the sum spent; but I was assured that both he and his officers were quite satisfied that the money was more than well spent, and that by means of these Statistics they had been enabled to introduce reforms and economies, the necessity for which would otherwise never have been known, and that generally the outlay which they incurred in the compilation of the Statistics represented only a very small percentage of the saving effected by their aid.

Necessity for them.

Value of Statistics.

Value of Statistics illustrated.

76. As a practical illustration of the usefulness of Statistics, the same President told me how he had been able to reduce the cost of handling a ton a mile over one of his Districts. It used to be some *mills* and a fraction. The District Officer, he knew, was sparing neither time nor trouble over his work. None the less, he told him that he must devise ways and means of knocking off that fraction. But just as the District Officer began to see some possibility of meeting the President's wishes, an order came for some large work to be done, the cost of which was to be charged to operating expenses. Ordinarily, a new force would have been engaged to do the work, but that would have increased, not diminished, the cost of carrying a ton a mile. He knew his President, and he knew that even unexpected work would not excuse his failure to do what he had been asked to, and therefore, that he must somehow or other contrive to do that work and at the same time knock off that fraction. He was made to think; and it eventually occurred to him that each gang of trackmen could spare a man for a few days without affecting the efficient maintenance of the road; so, instead of employing outside labour, he took one man from each gang and did the work; and with this, and other economies which he found possible when he looked more carefully into the details, he succeeded in meeting the President's wishes.

Without the Statistics, the attention of the President would not have been attracted to the item of cost per unit, and not only would that fraction have remained, but it would have grown larger.

With the Statistics, the closer analysis of his methods of working which the District Officer was forced to make, an analysis which the Statistics helped him to make, disclosed the fact that the work was not being performed as economically as he supposed, and led to considerable reduction in operating expenses, since the saving of even a small fraction in each unit totals up to a very appreciable amount when it is considered how many of those units go to make up the business of a railway.

All railways keep elaborate Statistics.

77. I have seen it stated by other visitors to America, both railway men and journalists, that the value which railway officials in America are credited with attaching to Statistics is over-stated; and that opinions are very much divided in that country as to their usefulness. On every railway in America which I visited I found the most elaborate Statistics, and it did not seem reasonable to suppose that the large sums which are spent in the preparation of Statistics would be spent if they did not have a definite and a *reproductive* value. They are more practical than that in America. I therefore enquired what foundation there was for the statement, and of the numerous officials of all grades, from Presidents down to District Superintendents, whom I consulted (and I discussed the question with several of each class), *I did not meet with one single person* who spoke in any way disparagingly of Statistics. On the contrary, as I have already stated, they said they could not possibly get on without them.

The function of Statistics is to test, in the first place, the human agency employed to do the work; in the next place, the mechanical agencies provided for the execution of the work; and, lastly, the normal physical conditions which influence and affect, adversely or otherwise, the performance of the work. They are intended to show not only whether the officer immediately in charge of the work has made intelligent use of the means at his disposal, but also whether the general management has been efficient in the performance of its duty by the provision of suitable means, and by the betterment of conditions which operate against economical management.

The executive officers consequently did not at first like the Statistics as they had an awkward way of showing them up, and they were perfectly frank in telling me so; but now that they have got over their objection to them on these grounds, they were as enthusiastic about them as the administrative officers.

Statistics must be used with intelligence to be of value.

Of course everyone recognises that experience and reflection are necessary for the intelligent application of all Statistics, and that Statistics used without intelligence may be not only of no value, but very harmful. But it is contended that, when used with intelligence, they help to impress all with the money value of the service performed and to bring sharply to their attention the cost of inefficient service, helping thereby to cut out a proportion of the numerous things that militate against an economical performance.

78. The system at present followed in the preparation of Statistics by the several railways is not uniform. Originally railway Statistics consisted of a sort of periodic balance sheet showing in the aggregate the amount of earnings, cost of operation, and the net result. These figures admitted of comparison *in the aggregate* with previous results, but there was nothing which afforded any possibility of analysing the results, of tracing them back to their causes, and of determining whether comparatively unfavourable results were due to avoidable or unavoidable causes. To supply these deficiencies, each railway from time to time modified and amplified its own system; and, although aiming at the same object, each railway has been a law unto itself in the development of its own system, with the consequence that there is great diversity of method *as to details.*

To overcome the difficulties which necessarily arise out of diversity of practice, the American Railway Association appointed a committee of its members, who were required to harmonise the various methods and suggest some system for presenting the Statistics for common adoption by all railways. There was no question as to the value of and necessity for Statistics. About that there was no doubt in the mind of anyone. It was

merely a question of introducing uniformity of practice, and this is made abundantly clear by the reports of the Committee.

Where the systems now in existence on the several railways differ so materially in regard to *details*, the task of harmonising the divergent methods and the views of the introducers of these methods was necessarily a very large and a very difficult one, and the progress made has been slow. But progress has been made, and the President of the Association told me that the Committee hoped before long to be able to make suggestions which might help to secure the object aimed at.

79. Meanwhile, each railway continues to improve its Statistics in the light of its own experience, and the tendency is not for Statistics to diminish but to increase in quantity and detail, the reason given being that the greater the detail the more easy is it to analyse and find out where things are going wrong.

The system adopted is not as comprehensive or as valuable on every railway as on some; and it was a noticeable fact that the railways which have devoted most time and attention to evolving some reasonable system are those which have succeeded in securing the best Results, Results here being low cost of operation per ton per mile with increased profits to the undertaking and increased dividends to the shareholders.

80. Half yearly or yearly Statistics *by themselves* were regarded as useless, since they covered periods in which the fluctuations might be large and delayed the application of the remedy where one was needed. The essence of check was held to be expedition in action so as to have facts before the memory grows cold.

Half yearly Statistics no use.

As a consequence, all Statistics in America are prepared by the month, (some few are by the week), after each month's figures those for the year up to date being shown; and the comparison is with the corresponding periods of the two previous years, and of the preceding month in the same year. All Statistics reach all the officers concerned by the 7th of the second month following the period to which they relate, that is, those for January are in the hands of all the officials by the 7th of March—the essential Statistics, however, reach them a good deal earlier—and all railways are striving to reduce the time to one month, and are very hopeful that they will succeed in doing so.

Statistics cover month or less.

Statistics issued within five weeks of close of month.

81. The preparation of Statistics in a useful form for purposes of comparison was simplified by the system of organisation adopted on American railways. With the railway divided up into a series of Districts, all operations and all expenditure in which are in the entire control of one man, the District Superintendent, it was possible to hold that one man alone responsible for the Results. There is no division of responsibility, and the number of people helping the District Superintendent to produce Results is so small that he is effectively able to control their operations.

Preparation simplified by organisation.

District the unit.

All Statistics, therefore, are prepared for Districts in the first place. They are next summarised to show the operations of the next unit—the Division—and are finally summarised to show the operations of the railway as a whole. The Statistics are supplied to all the officers concerned, from the President downwards, the President receiving his in a pocket manual which he carries with him everywhere.

Statistics prepared by District, Division and Railway.

82. Immediately on receipt of them, the Vice-President in charge of the Transportation Department and the General Manager have a meeting of the General Superintendents, the Auditor being present; and every item in the Statistics is gone over. The General Superintendents then call a meeting of their District Superintendents and go over the figures with them.

Use made of Statistics.

At both these meetings, the General Manager and the General Superintendent respectively, take nothing for granted, but look into every point

Nothing taken for granted.

carefully; and it is rare for some defect not to be discovered or for some improvement not to be found possible.

The Meeting of the District Superintendents is held as soon as possible after the Statistics have been issued, not always at the same place but in different Districts each time, and keeps the District Superintendent away from his District about 48 hours. Apart from the benefits resulting from a personal discussion of the Results, these meetings are regarded as very valuable in that they bring all the District Superintendents together and enable them to see each other and compare Results; and by being held in a different District each time, give them some acquaintance with the other parts of the railway.

Advantages of meetings.

This procedure in all this detail is not followed on every railway. On all, however, where such Results as are brought out by the Statistics compiled are not satisfactory, the consideration of them is always by personal conference with the responsible officers.

Standard unit. Results.

83. The standard unit is the Passenger and Ton mile, income and cost. The cost per ton-mile is directly affected by the number of train-miles, and this again by the load in each train and in each vehicle on that train. All Statistics, therefore, are designed to bring out these results.

The District Superintendent who can turn out at the lowest cost most ton-miles, since the freight traffic represents the bulk of the business (much allowance being made for the conditions of his District), is the man who is regarded as doing best.

The healthy emulation that this system leads to is held to be responsible for the great economies which have been introduced in American railway operation in recent years, and it is not difficult to realise the great benefits which might result from such a system.

Statistics, by whom prepared.

84. The Statistics relating to Train, Engine, and Vehicle mileage are prepared from the Guard's reports in the office of the General Superintendent of Transportation at the headquarters of the railway. All other Statistics are prepared in the office of the Comptroller. The District Superintendent prepares no Statistics, as it is considered not only that the work can be more economically done in one place, but that it can be more expeditiously turned out when so concentrated.

Expenses—division of, between passenger and freight.

To arrive at the cost per passenger and ton mile it is of course necessary to divide up the expenditure under Passenger and Freight. The method pursued differs on each railway. Where it is possible to definitely attribute any item of expenditure to Passenger or Freight, the District Superintendent, in his monthly operation sheet, that is, in his salary and other bills of expenditure, and all Stations and District offices in their returns, so show it. All the other items are shown by them as "Common." The "Common" items are then divided between Passenger and Freight, on some railways on the basis of gross revenue derived from each, on others on the basis of Passenger and Freight revenue train mileage, on others on the basis of Passenger and Freight Locomotive mileage.

In allotting the General Expenses, that is, those falling outside the District Superintendent's control, between Passenger and Freight, and between each District, the same procedure is followed, that is, items definitely chargeable to Passenger and Freight are so charged, and are divided between Districts on the basis adopted; and "Common" items are divided on the basis adopted.

85. To enumerate all the returns prepared to bring out these results and to explain the method of their preparation, would be out of place in a general report such as I assume mine is expected to be. (I have all the information, and can furnish it to the Government of India at any time that

they desire.) I propose, therefore, to record here only such information as may in a general way indicate the system followed.

86. I have stated in paragraph 84 how expenses are divided between Passenger and Freight traffic and between each District. They are further subdivided, District by District, and Division by Division, to show the nature of the service performed, as follows :— Expenses how subdivided.

EXPENSES :—

Station Service : $

Station agents, clerks, and labourers	
,, supplies	
,, furniture	
Switchmen, flagmen, and watchmen	
Switching	
Stockyards	
Telegraph expenses	
Proportion of operating expenses of terminals	
Operation of leased lines	
Total	

Train Service :

Conductors	
Brakesmen	
Baggage-men	
Train supplies and expenses	
Heating and lighting cars	
Oiling cars	
Cleaning passenger cars	
Total	

Engine Service :

Engineers and firemen	
Engine dispatchers, wipers, and round house labourers	
Fuel for locomotives*	
Oil, tallow, and waste for locomotives	
Other locomotive supplies	
Water supply	
Total	

Contingencies :

Damage and loss of freight	
,, and loss of baggage	
,, to property	
Stock killed or injured	
Personal injury	
Wrecking	
Car mileage.—Balance	
Hire of equipment	
Superintendence	

* In estimating this charge, the average cost per ton of all the coal used is arrived at, and the District consumption charged on that basis.

Statistics.

Para. 86.

Contingencies—cont.	$
Other transportation expenses	
Expenses of sleeping cars	
„ dining cars	
„ buffet cars	
Total	
Total conducting transportation	
Maintenance of Equipment:	
Repairs of cars (freight and passenger)	
„ work cars	
„ locomotives	
Other equipment expenses	
Supervision of equipment	
Total	
Maintenance of Road and Structures:	
Removal of snow and ice	
Repairs of roadway and track	
„ tunnels	
„ cribbing and bulk-heading	
„ bridges and culverts	
Cattle guards, road crossings, and track signs	
Renewals of rails	
„ ties	
„ fastenings	
„ frogs, switches, and miscellaneous track material	
Maintenance of leased lines	
Repairs of fences	
„ snow fences and snow sheds	
„ buildings	
„ water supply	
„ docks, wharves, landings, and inclines	
„ telegraph	
„ shop tools and machinery	
Total	
General Expenses:	
Traffic Department expenses	
Outside agencies	
Advertising	
Salaries and expenses of General Officers	
Salaries of clerks	
General Office expenses	
Legal expenses	
Rent of buildings, tracks, yards, and terminals	
Insurance	
Stationery and printing	
Miscellaneous	
Total	
Total Operating Expenses	

87. The business done is then shown, and the results follow, thus :— Business done and results.

BUSINESS DONE :— Business done.

Passengers (public and free separately) :

Number of passengers carried - - -
„ „ „ one mile. (Passenger mileage.)
Gross earnings from passengers - - -
Average earnings per passenger (public) per mile -
Average distance travelled by each - - -

Freight (public and Company's freight separately) :

Number of tons carried - - - -
„ „ one mile. (Ton mileage) -
Gross earnings from freight - - - -
Average earnings (public traffic) per ton per mile -
Average distance each ton carried - -

Revenue from other sources of traffic :

Gross revenue - - - - -
Working expenses - - - - -

Net revenue - - - - -

RESULTS :— Results

Average mileage of road operated - - -
Number of trains run. Passenger - - -
„ „ Freight - - -
Train mileage. Passenger - - - -
„ Freight - - - -
Average potential load of a freight train - -
Average number of passengers per mile of road operated
„ „ tons of freight per mile of road operated.
„ „ passengers per train per mile -
„ „ tons of freight per train per mile -
Vehicle mileage. Passenger - - - -
„ „ Freight (loaded and empty separately) in the direction in which traffic preponderates.
„ „ Freight (loaded and empty separately) in reverse direction.
„ „ Total of each - - -

Average number of vehicles per train per mile—
Passenger - - - -
Freight, loaded - - -
„ empty - - -
„ Total - - - -

Statistics.

Paras. 88—89.

Average number in each vehicle per mile—
Of passengers - - -
Of tons of freight per loaded vehicle -
Of tons of freight per vehicle, loaded and empty included.

Average carrying capacity of a freight vehicle - -
Average cost of operation per passenger train - -
" " " freight train - -
" " " passenger vehicle -
" " " freight vehicle -
" " " passenger mile - -
" " " ton mile - -
Average number of engines in service - - -
Number of trips run by all engines - - -
Engine mileage - - - - -
Engine service in hours. Potential - - -
" " Actual - - -
" " Miles per hour while in service.

Average cost of operation *per train per mile*, and average cost *per* 100 *tons one mile* of—
Station service - - - - -
Train service - - - - -
Engine service - - - - -
Contingencies - - - - -
Maintenance of equipment - - -
" road and structures - -
General expenses - - - - -

Total Operating Expenses - - -

88. As before stated all these figures are worked out for, and up to the close of, each month for each District, and a comparison made with the corresponding months of the two previous years and with the month immediately preceding in the same year.

Guards' Report—basis for mileage Statistics.

89. To permit of the vehicle mileage for each District being arrived at, the guard of every freight train submits a report to the General Superintendent of Transportation (one of the Staff Officers of the General Manager) in which he shows—

The initials, that is, class of each vehicle.
The number of each vehicle, loaded and empty distinguished.
The station at which attached and detached. (The names of stations are represented by numbers and not by code abbreviations).
The destination of the Vehicle.
The description of the contents of the Vehicle.
The tare and carrying capacity of the Vehicle.
The weight of its contents.
The gross weight of the Vehicle.
The rating of the Vehicle for the engine load, where this method of calculation is in force.
The condition of seals on each side door and the condition of the end doors where they exist.
The number of miles run by the vehicle on the train.

From this report is calculated all the information in connection with Engine, Train, and Vehicle Mileage.

Statistics of Passenger Service.

90. For the Passenger service, each Guard sends in a statement showing the number of passengers on his train, stations between which they travelled, and the distance they travelled *on the District* to which he is attached. These particulars are summarised in the Audit office for the month. The miles travelled are then converted into money by the application of average rates per mile based on the preceding month's actuals for similar journeys, and the total revenue from the train's business for the month determined. The total is then divided by the number of trips and the quotient divided by the length of the trip to ascertain the average income per mile run by the train. These results are worked out for all passenger trains, so that it is possible for officers to see what business each train is doing.

In America all passenger cars are end opening and communicate with one another, and the Guard of the train is also the Ticket Examiner and the Ticket Collector. It is, therefore, possible for these returns to be prepared with accuracy, as the Guard only notes the passengers he finds actually travelling in his train.

91. A statement is also prepared monthly, showing the business done at each station on the railway under Passengers forwarded, and Freight forwarded and received.

Cost of preparing Statistics.

92. The work of preparing these Statistics has been very much systematised, and by the use of labour saving devices, both labour and cost have been reduced and expedition in the presentation of the returns secured. Judged merely by the sum spent, the cost still is large; but when the amount is compared with the number of units which go to make up the railway and its business, it is quite insignificant. But by whatever standard the outlay is judged, the Results are considered to fully justify the expenditure. It is by means of these Statistics that the American Railways have been able to reduce expenses generally and to increase the load in their vehicles and in their trains and consequently to reduce the cost per ton mile, and it is to no small extent because of these Statistics, that those railways which have adopted the most elaborate Statistics, and learnt the lessons which they teach, are in as good a financial position as they are to-day.

93. Sufficient emphasis cannot, however, be laid on the three other factors which have helped to make the Statistics of value, namely,—

First, the organisation of American Railways which divides up the line into several small units each complete in itself, with all responsibility concentrated in one man, thus permitting of a proper check being exercised;

Secondly, the system (referred to in paragraphs 38 *et sequitur*) which judges by Results, and is quick to recognise the labour, intelligence and energy which produce the best Results; and

Lastly, the publication of the Statistics, which enables the capitalist or the shareholder to measure the quality of the management and to take the steps necessary to secure efficiency.

CHAPTER III.

GAUGE.

GAUGE—DIVERSITY OF.

Gauge—Diversity of.

94. So little did I expect to find any information which might help India to a possible solution of her gauge difficulty, that I did not include this question among those to be studied while I was in America, and it was only in the course of a conversation with a non-railway man that I quite accidentally came to learn that information which might prove of great value existed, if only it could be found. I accordingly devoted my attention to the subject, and after a good deal of trouble succeeded in obtaining the information which follows.

Gauge of Railways prior to 1886.

95. Prior to the year 1886 America had railways of all gauges, 6 ft., 5 ft. 6 in., 5 ft., 4 ft. 10 in., 4 ft. 9 in., 4 ft. 8½ in., and lesser gauges. What the exact mileage was of each gauge I was unable to learn.

Inconvenience of diversity of gauges.

As time went on, and the systems and the traffic developed, it was seen that prompt and economical transportation required that the vehicle, once loaded, should go on to its destination without transfer. To secure this end, the 6 ft. lines attempted to extend their wide gauge to distant centres of trade, while the 4 ft. 8½ in. and 4 ft. 10 in. gauges tried to overcome their difficulties by changing the tread of their wheels so that they might run on both gauges. This did not prove altogether satisfactory, and a compromise gauge of 4 ft. 9¼ ins. was adopted by the 4 ft. 10 in. lines. The 5 ft. 6 in. gauge lines were apparently increased to 6 ft.; and the 6 ft. lines laid down a third rail for the 4 ft. 8½ in. and 4 ft. 9¼ in. lines, so that either wide or narrow trains could be run, and all equipment kept in use until the gauge was made uniform. It became possible then to run a vehicle from the Atlantic to the Pacific, north of the Ohio river. South of the Ohio, however, the standard gauge was 5 feet, but there were a great many railways on the 3-feet gauge.

Uniformity of gauge decided upon.

The extreme inconvenience of this break of gauge was seriously felt. Methods for ameliorating the difficulty, to which I shall presently refer, were adopted, but the expense of these, and the time and labour required to operate them, were considered too serious to be tolerated, and it was arranged at a conference of the Presidents of the different railways, held in the summer of 1885, that all railways should be one gauge, and that the change to the gauge adopted should be made during the ensuing year 1886.

4 ft. 9 in. gauge adopted as standard together with 4 ft. 8½ in. gauge.

In February of the latter year a conference of General Managers was held, and it was decided that the standard gauge should be 4 ft. 9 in., but that railways on the 4 ft. 8½ in. gauge need make no change. The 4 ft. 8½ in. has since practically become the standard, though some roads, notably the Pennsylvania line, adhere to the 4 ft. 9 in. gauge. All vehicles are, however, interchangeable between these two gauges.

It was at the same time decided that the conversion of gauge should be made at the end of May that year (1886), two days being allowed for the change.

Uniformity adopted in May 1886.

In May 1886, therefore, the gauge for all the railways in America, that is, all but the unimportant branches, became 4 ft. 9 in. and 4 ft. 8½ in.

Mileage converted.

96. Exactly how much mileage was converted from one gauge to another under this decision I was unable to ascertain; but the total would appear to have been 13,000 miles of main track and 1,500 miles of sidings.

It would serve little good to state here how the change was made. I have the information, and can furnish it at any time. The necessity for it had been foreseen for years, and all new stock had been built so as to facilitate the change when the time came. When, therefore, it was made, there was little disturbance to the business of the railway, and little inconvenience to the public.

Methods adopted while gauges differed.

Inconvenience of transhipment.

Bogie type of vehicle suggested a remedy.

Remedy adopted.

97. Prior to the introduction of a uniform gauge, the ordinary methods of transhipment from vehicle to vehicle were at first followed. But the inconvenience and expense of this were realised by both railways and consignors and consignees of traffic, and the railways sought for some method of avoiding it. The bogie type of vehicle had by this time come into more or less general use in America. With the double bogie or truck, the bodies and the running gear are only connected together by the centre pins or kingbolts, and it is comparatively easy to shift the bodies from one set of trucks to another.

It occurred, therefore, to someone that transhipment could be saved by lifting the body of the vehicle off the bogie trucks, and transferring it bodily from the trucks of one gauge on to the trucks of the other. This arrangement was accordingly adopted, and not only all goods, but all passenger vehicles were so dealt with.

Hoist at first used for transferring vehicles.

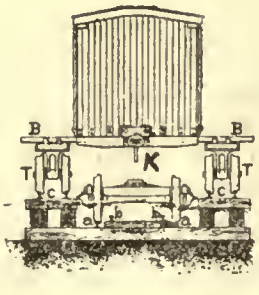
98. At first, the bodies of the vehicles were transferred by means of hoists. The hoist handled one passenger or two goods vehicles at a time and it took 20 minutes to transfer a train of four passenger vehicles. For goods vehicles, it was found that one hoist could transfer from 100 to 125 vehicles in an ordinary working day easily.

Sunken tracks subsequently adopted.

99. The hoist, however, necessitated the lifting of the body of the vehicle, and it occurred to a Mr. Ramsey that it was foolish to lift the heavier weight, and he designed a method by which, instead of raising the bodies of the vehicles, the trucks were lowered, by running down an incline leading into a pit, while the bodies were supported on small trucks placed on each side of the main line.

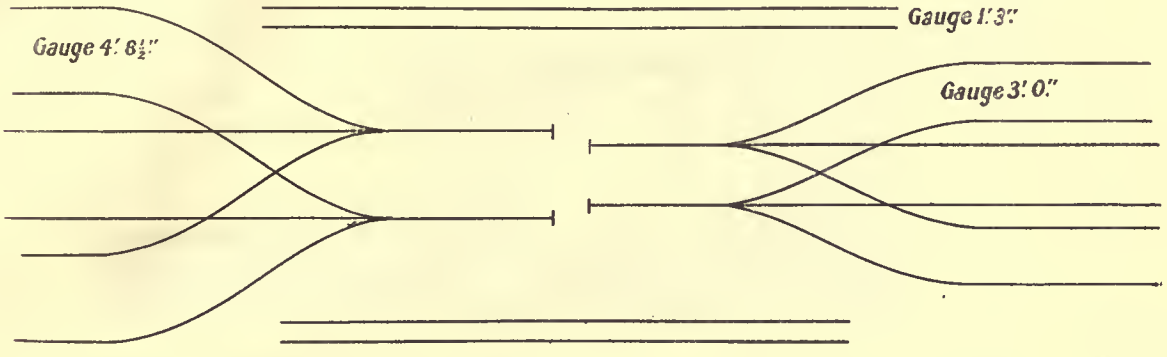
Design of pit.

100. The construction of the pit will be better understood from the following diagram for which, and the descriptions of it, I am indebted to Mr. W. H. Boardman, Editor of the "Railroad Gazette."



It will be seen that two lines of rails, a a and b b, of the two different gauges are laid in the pit, which is about 20 inches deep. On each side other lines of rails, c c, are laid on a 15-inch gauge, on which the side trucks T T run, and which support cross beams B B on which the body of the vehicle rests. Description of method.

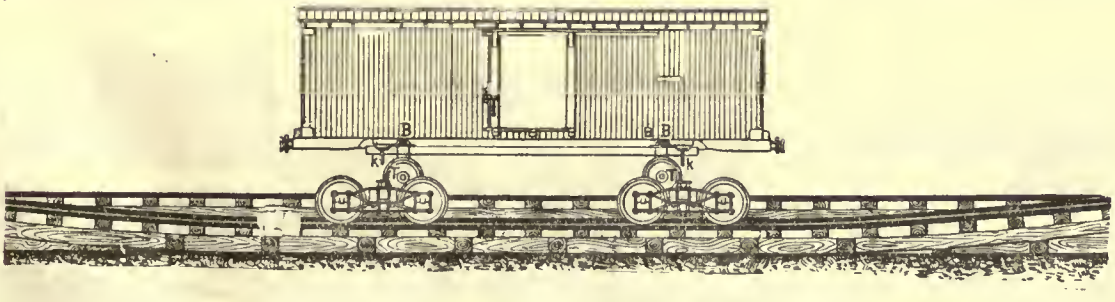
The lines of the two gauges inside the pit, though shown as continuous, really terminate in dead ends, placed at a point just far enough from the beginning of the pit to permit of the free disengagement of the bodies from the trucks, thus—



The trucks were removed from the pit by hand to sidings running off the depressed lines. Trucks removed by hand.

101. The process of transfer was as follows :— Process of transfer.

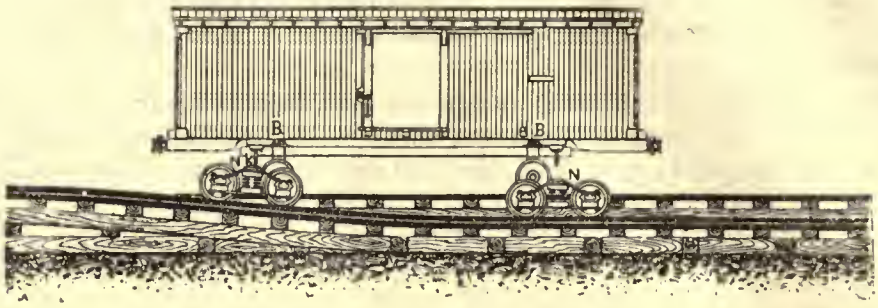
The side trucks T T were first run alongside the vehicle, and the cross beams B B placed underneath the body and on top of the side trucks. The vehicle was then run over the pit. As soon as the trucks of the vehicle reached the incline they of course descended, which caused the weight of the body to rest on the cross beams B B, and by the time the trucks of the vehicle reached the dead ends, they were entirely disengaged from the king-bolts K K as shown in the following diagram :— Removal of trucks.

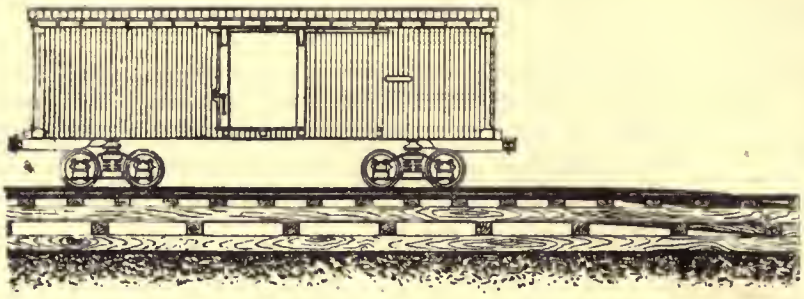


The body of the vehicle continued moving on. Meanwhile, the trucks of the opposite gauge were pushed or pulled forward up the incline, until they got into position, when the king-bolt K engaged with the truck centre plate. The vehicle still continued to be moved on until the weight was taken off the cross beams B B, when they were removed, and the vehicle was ready to proceed on its journey. Replacement of trucks.

Gauge.
Para. 102.

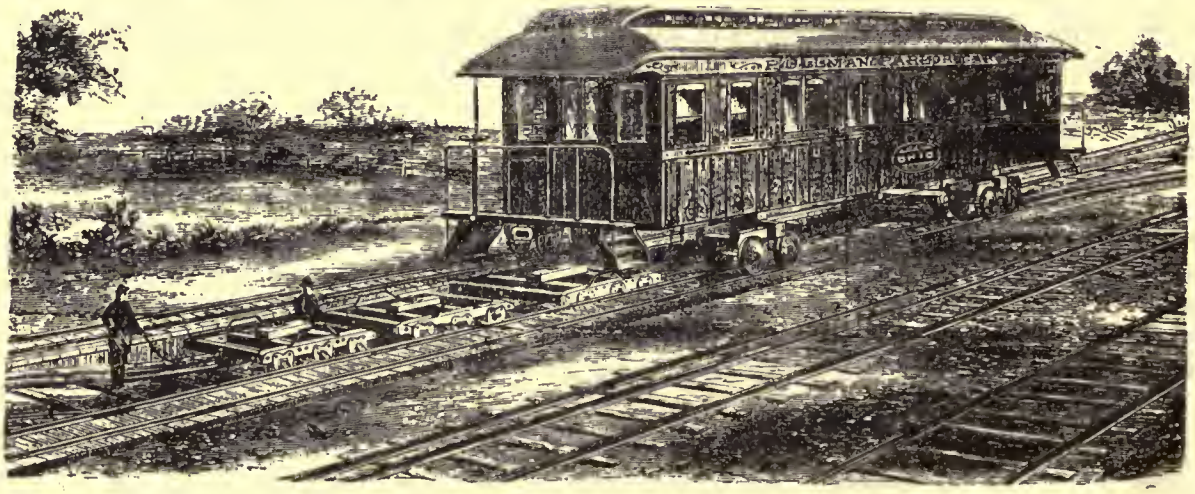
The process may be better understood from the following diagrams :—

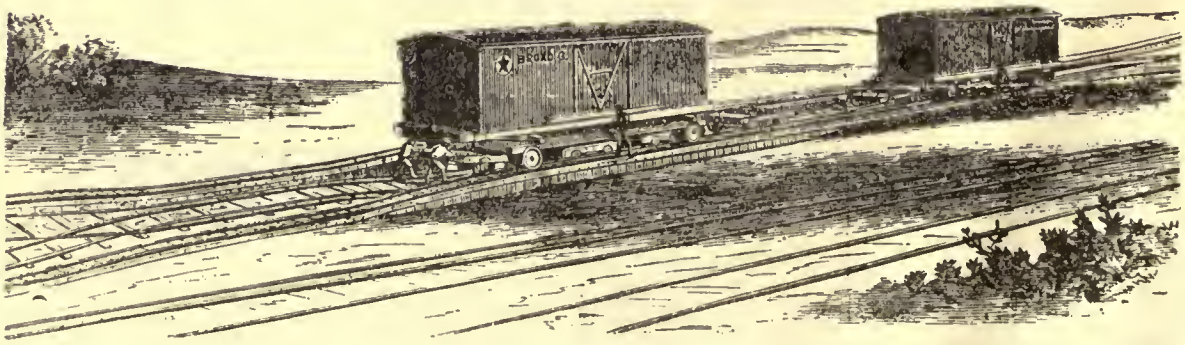




Perspective view of operation.

The following diagrams give a perspective view of the arrangement with a passenger and a goods vehicle in the process of transfer.





Method extensively used in America.

102. The method was extensively used in America where there was a break of gauge, the bodies of broad gauge vehicles being transferred to narrow gauge trucks, and *vice versâ*. It was found expeditious and economical when compared with the old method of car to car transhipment, and the only inconvenience ever experienced was when the supply of trucks gave out.

103. The time occupied in the transfer of vehicles under this process was computed, under ordinary conditions, at 10 cars to the hour; but on a trial of speed, vehicles have been transferred in 1½ minutes per vehicle. Time occupied in transfer.

104. As to the safety of running the broad gauge bodies on the narrow, especially the 3 feet, gauge trucks, the experience of Mr. Randolph, Superintendent of the Washington City, Virginia, Midland and Great Southern Railroad, was expressed in 1880 as follows:— No danger in running broad gauge vehicles on narrow gauge track.

> "We are daily transferring freight cars between the 4 ft. 8½ in. and 3ft. gauges, and even where the cars were badly overloaded with ore, the transfers have been made without difficulty; and although we have on the narrow gauge very sharp curvatures and heavy grades, the standard car-bodies upon our narrow trucks have given no trouble whatever."

Mr. T. Mellon, Superintendent of the Ligonier Valley Railroad, answering the question "Whether the broad gauge car-bodies run steady in narrow-gauge trucks," replied:—

> "This is the point that bothered us before we tried the experiment, but I am able now, after several months experience, to say that there is no difficulty in this respect whatever. We ship and transfer cars of cattle, bark, lumber, ties, &c., without any special care of adjustment of the load to the centre of the car, and have not, in any instance, discovered the slightest tendency to sway or upset. The other day a Fort Wayne car arrived on the Pennsylvania Railroad loaded with a portable saw-mill, boiler, engine, &c., to go up our road—quite a heavy and top-heavy load—yet our men transferred the car-body as it stood, without hesitation, and took it to Ligonier without difficulty."

105. The practice of doing so showed how much could be done by broad gauge lines towards the widening of and increasing the weight in vehicles. In fact, it was the possibilities which were here demonstrated, which have since led to the widening of the American vehicle and to the great loads now put in them.

106. I was further informed that no hesitation was felt at the time in running goods trains composed of broad gauge vehicles on 3 ft. gauge trucks at a speed of 30 miles an hour, a speed at which fruit traffic had frequently to be run. Of course the narrow-gauge trucks were constructed with heavy journals to carry the broad-gauge vehicle, and when so constructed no accidents resulted from the practice. Broad gauge vehicles on narrow gauge trucks run at high speed.

107. In India, the supply of vehicles on bogies is limited. The 5 ft. 6 in., or broad gauge lines, have very few; but most of the metre gauge lines have a fair number. With the standard dimensions on the metre gauge lines so restricted, it might be difficult, even in the case of those broad gauge lines which have bogie vehicles, to run the bodies of these vehicles on to the metre gauge lines, though something might be possible even in their case; but the difficulty would not exist in the case of the metre gauge vehicles which could be run on broad gauge bogies on broad gauge lines. India—applicability of system to.

108. The Rajputana Malwa metre gauge railway exchanges a very large amount of goods traffic with the broad gauge lines by which it is surrounded, the heaviest business being done with the Bombay Baroda and Central India broad gauge railway. It is the best equipped of all the railways in India with bogie wagons, and is the most fortunately circumstanced in being worked by the railway with which it does its heaviest business. The introduction of the Ramsey method of transhipment in connection with the traffic exchanged between the two gauges of this system, could therefore be very easily introduced. It would prevent a great deal of delay which now Adoption of system possible on Rajputana-Malwa Railway.

occurs at Sabarmati and Ratlam in the transhipment of traffic from one gauge to the other, and would save a great deal of the money now spent in the operation. The bulk of the traffic exchanged is from the metre to the broad gauge, and the metre gauge vehicles which went on to the broad gauge could bring back the return traffic from the broad to the metre gauge, and thus avoid vehicle to vehicle transhipment between the system altogether.

Introduction in connection with the passenger service possible.

109. In America, both passenger and goods vehicles were transferred from one gauge to the other. There are a great many bogie carriages on the Rajputana Malwa Railway, and there is a large exchange of passengers, luggage, parcels, and mails between the two gauges at Ahmedabad. It might, therefore, on consideration, be found desirable to adopt the Ramsey system in connection with the passenger traffic also. The time taken in making the transfers would probably be less than that now taken to transfer the contents of one train to the other, and could be made without all the trouble that passengers and the railway staff are now put to.

110. Where solid trains could be run through from the metre to the broad gauge (and there does not appear any reason why this should not be possible considering the volume of the traffic interchanged), no change would be needed in the bodies of the metre gauge vehicles, but where these vehicles are run intermixed with broad gauge vehicles, different couplings, and side buffers would need to be provided suitable for running on the broad gauge.

Policy desirable.

111. The benefits from the avoidance of transhipment are so well recognised that it would seem worth consideration by the metre gauge railways in India whether it would not be in the best interests of their traffic to replace their four-wheeled stock by bogies, and to make arrangements at all junctions between the two gauges for the adoption of the Ramsey system of transfer. It costs comparatively little to introduce, and the space required for it is nothing like so great as that needed for an ordinary transhipment yard. It would save much of the time and money now spent in transhipment, expedite traffic generally, avoid the breaking of bulk and the handling of goods at an intermediate point, and in other ways save a great deal of labour at the junction. What is perhaps of as great importance, the long delays which now occur to vehicles of both gauges at the junctions, delays which necessitate the up-keep of a larger supply of stock than would be necessary if there was no break of gauge, would be entirely avoided.

Advantages from military point of view.

I have refrained from touching upon the advantages of this system from a military point of view. Its possibilities would appear to be very great, and in the general introduction of the Ramsey system of car transfer might be found a comparatively easy solution of the gauge difficulty in India.

Ramsey system would not be new to India.

112. Since the foregoing was written, I have been informed by Mr. F. R. Upcott, C.S.I., Government Director of Indian Railways at the India Office, that the Ramsey system of car transfer was in use at Sibi on the Bolan railway on the North-West Frontier of India until the Sibi-Quetta line was converted from metre to broad gauge. Why the system was not tried in other parts of India, I have been unable to learn.

FERRIES.

Ferries—use of, in America.

113. Intimately connected with this question of how to deal with traffic when there is a break of gauge, is the closely allied one of how to deal with traffic when nature interposes physical obstacles to break the continuity of the lines. The problem is one which America has had to face in a greater degree than any other country in the world. In the North there are the great lakes, and all over the country there are rivers and pieces of water which intervene between one system of railway and another, or between two parts of the same railway, which either cannot be brought into physical contact at all, or can only be bridged over or tunnelled under at a prohibitive cost.

Cars transferred rather than tranship.

114. The difficulty has been met by the free use of ferries; and so great are the objections to transhipment held to be by the users of the railways, that whenever this is practicable, or for any reason desirable, not only are wagons carried bodily over, but whole passenger trains are similarly transferred across the breach.

Business between New York and all railways, and between railways east and west of Hudson done with ferries.

115. The city of New York, as is well known, is on an island, and is separated from the main land on one side by the Hudson (North) River, and on another by the Harlem River. The only railways which have an entrance by railway to the city of New York are the New York Central and Hudson River and the New York New, Haven, and Hartford Railroads, both over the same metals. These railways lie east of the Hudson River, and are separated from all the other railways serving New York by that river. The Hudson River is unbridged. Rail communication between New York and the railways west of the Hudson River, and between these latter and the railways east of the Hudson, is, therefore, broken, and the termini of all the railways west of the Hudson River are on the main land. A large part of the traffic which the roads west of the Hudson River carry is to and from New York City, but a larger part is to and from stations on the railways east of the Hudson.

New York arrangements.

116. To take first the case of the New York traffic, the passengers are made to alight or take train at the termini on the main land, but are carried across the water in ferries provided by the railway, one railway running ferries to and from four different points, and all the railways providing a very frequent service; but all freight vehicles are carried across in wagon ferries to and from the several goods termini on the island, no extra charge being made for the service.

Arrangements between railways east and west of Hudson.

117. The traffic between railways east and west of the Hudson is somewhat differently dealt with. Passengers usually alight at the termini and find their own way to the railway terminus of the roads east of the Hudson and *vice versâ*, being of course ferried across the water by the railway; but there is an important traffic between Washington and Boston and stations lying between, and to save these passengers the trouble, expense, and delay of finding their way from one railway station to another across Manhattan island, the Pennsylvania Railroad carries the train bodily on a car-ferry from their terminus to the New York, New Haven, and Hartford Railroad goods terminus at Harlem River station *a distance of about nine miles.*

Whole passenger and all goods trains transferred on ferries.

All freight traffic is similarly exchanged by all railways west of the Hudson not only with the New York, New Haven, but with the New York Central also; and the volume of this traffic is very considerable, as it includes a large part of the coal used in the New England States.

Position at Detroit.

118. At Detroit, in Michigan, the Detroit River separates the United States from Canada, the town on the Canadian side being Windsor. There is an enormous steamer traffic over this river between the great lakes, and the river could only be bridged, so as not to interfere with this traffic, at a prohibitive cost. A large part of the traffic from Chicago to the eastern

seaboard passes over this route, *viâ* the Niagara Falls and Buffalo; and there are several other routes competing for the traffic. If transhipment was resorted to, the whole traffic would follow the other routes. Every passenger vehicle and freight wagon is, therefore, carried across bodily on car-ferries.

At Detroit all passenger and freight traffic transferred in vehicles in which it arrives.

119. I had heard a good deal about the arrangements at Detroit, and I went there specially to see them.

There are three barges employed in the service. Each barge holds 12 ordinary coaches or nine Pulman cars, or 18 to 21 wagons according to their length, each has three lines parallel to one another running from end to end, and the loading of one barge with 18 wagons occupied just eight minutes by my watch.

The train by which I crossed consisted of seven cars (five passenger cars and two baggage cars, all bogies). From the time the train arrived at the wharf to the time it leaves, 10 minutes are allowed. My train was boarded by two shunts, half on each of the outer lines (the middle line was occupied by wagons), and the operation took $3\frac{3}{4}$ minutes. The barge was under way within five minutes of the train reaching the dock. It took 11 minutes to cross the river, four minutes to couple together the cars at the Windsor end which was done by the shunting engine. The train engine then coupled on while the rear cars were still on the barge, and the train was on its way within $5\frac{1}{2}$ minutes of the barge anchoring. The whole time occupied between the train arrriving at the dock on one side and leaving on the other, was $21\frac{1}{2}$ minutes, and 30 minutes are allowed for the operation. The distance between the two points is one mile; and the cost of operating a single trip with a full load is about $12 or Rs. 36.

Arrangement of wharfs.

120. At both Detroit and Windsor the wharf runs parallel with the river, and the head of the docks is enclosed by walls built of upright logs, into which the head of the barge fits. At Detroit the bank is low, and the line is level up to the wharf, but at Windsor there is a high bank, and to enable the immediate approach to be on the level, so as to permit of wagons being shunted on to and off the barges by engine power, a road, the gradient of which is 1 in 176, has been cut through the bank down to the level of the barge. There is, of course, the usual rise and fall of tide, but this is easily controlled, so that it is always possible to shunt on and off vehicles with engine power.

Arrangement of barges.

121. The barges are so constructed that the vehicles can run straight on to them without needing turning. At one end the barges are fitted with buffer stops: the vehicles are kept coupled together, and the car near the entrance end is secured by moveable scotch blocks which come close under the wheels, and by safety chains.

1,800 cars transferred daily.

122. The highest number of vehicles transferred in one day with three barges working all day and two all night was 103 coaches and 1,850 wagons or 1,953 of all kinds *each way*, and the normal number is 937 daily *each way* between Detroit and Windsor. Except during busy times only two barges are employed on the service. The barges were apparently light in construction, but were capable of taking any engine that was on the road, and the shunting engine always went on to the barge to place and remove vehicles.

Arrangements on Pere Marquette rail way more remarkable.

123. A still more remarkable instance of the use of ferries is to be found on the Pere Marquette Railroad. This line runs across the State of Michigan, between Lakes Huron and Erie in the east, and Lake Michigan in the west. A good deal of its business comes from across the latter lake, that is, from the west. To secure a share of it, and also to afford a shorter route from the west to Canada, therefore, this railway runs its vehicles, both

passenger and freight,* aeross Lake Miehigan in barges or ear-ferries the capaeity of whieh is 30 vehieles eaeh, from Milwaukee to Ludington, a distanee of 97 miles, and *vice versâ*. The barges with the passenger vehieles run to scheduled time, and take 11 hours 20 minutes on the journey, that is, they travel at an average speed of 8½ miles an hour, and the train starts 10 minutes after the arrival of the steamer.

Use of ferries forced on railways by competition.

124. Like everything else in Amerieau railroad praetice, these steps were foreed on the railways by eompetition. One railway tried to get the better of its neighbour, and started a wagon ferry. All the others had to follow suit if they wanted to keep their business or to get any business at all. But now that they have got these wagon or ear ferries, they say they do not understand how they ever got on without them and would not now abandon them if they were given the opportunity to do so. They eonsider they are mueh more eeonomieal than the old methods of transhipment, and that they involve far less labour to everyone, and save a great deal of damage and loss to the goods.

But would not now abandon if allowed to.

Argument justifying the praetice of American railways.

125. The way it was put was this: If there was no physieal obstaele, you would not hesitate to eontinue your metals on to the point you desired to reaeh and you would run your trains over the metals. In other words, in the ease of the Pere Marquette line, you would build 97 miles of railway. Nature, however, makes it impossible for you to do this, so you build a few yards of railway only, but instead of plaeing them on an immovable surfaee, you lay them on a floating surface; and instead of *hauling* your vehieles, you *carry* them. By taking your trains over the same distanee in a barge you arrive at the same result, with this differenee, that you do not require to spend anything like the same money in the eonstruetion of your road bed. Your motive power eosts little if anything more, and the expense of maintenanee is infinitely less. Of eourse, you eannot travel so fast as you could if the rails were aetually continuous, but you aeeomplish the journey in a far shorter time than would be possible if you went round, where this is praetieable, all the way by rail, and you save your passengers and their goods all the ineonveniences resulting from transhipment at short intervals. The argument seems indisputable where the physieal obstaeles are insuperable as in the ease of the Pere Marquette railway or where the expenditure neeessary to overeome the obstaele would be prohibitive as in the ease of Detroit, and, I might add, New York.

India—applicability of the system to.

126. Of eourse, if there is a break of gauge eombined with the physieal obstaele, as is the case with the railways north and south of the Ganges in India, the question beeomes somewhat eomplieated. Assuming that a bridge is impraetieable on aeeount of the eost, if the metre-gauge vehieles were on bogies and the Ramsey system of ear transfer were adopted, the introduetion of ear ferries would overeome the physical obstaele altogether. Though the *line* eannot be made continuous, it is possible to produee the same result *in effect*, and that is how Amerieau railways would deal with the quesion if they were eonfronted with the problem which the railways north and south of the Ganges have to deal with. But even without the Ramsey system of car transfer, it would add greatly to the eomfort of passengers, and to the seeurity of the goods traffic, if transhipment from railway vehiele to ferry and ferry to railway vehiele at an interval of a mile or two only, could be avoided.

* Grain, which is always transported in bulk, is not carried in the wagons, but is transferred through elevators to steamers, that being the most economical way of dealing with this particular traffic.

CHAPTER IV.

GOODS RATES.

RATES FOR GOODS.

Theory governing fixing of Rates.

127. The generally accepted theory in regard to rates for the carriage of goods is to "Charge what the traffic will bear."

If the supply of any particular product was limited and its quantity definitely known, and if, further, there was a market for every ounce of that product, it would, no doubt, be possible to say what rates for its carriage that particular traffic could bear.

But there are few of this world's products which are so circumscribed; and the theory as to the fixing of rates, in practical application, becomes, "Charge what, in the judgment of the authorities concerned, the traffic will bear."

128. In America, railways were private corporations working for dividends, and rates were fixed which, in the judgment of the rate-makers, would move all the business requiring to be moved, and yield a sufficient income to pay a reasonable dividend to the stock-holders. These rates were not regarded as in any way limiting the traffic; and, some years ago, perhaps few people would have been found who would have said that the rates were not reasonable, or that they were in any way hampering the development of business.

Competition brought out fact that rates were limiting traffic.

129. But the construction of new railways and the opening up of new markets set up competition, at first between carriers both by rail and water, and later between not only carriers, but also between different trade centres and different ports, and soon forced down the rates, forced them down in a great many cases to a point where they ceased to be remunerative.

Meanwhile, under the influence of these low rates, factories and workshops began to spring up everywhere, and the result showed that the former rates were obviously not what the traffic could bear, and that they had been limiting the output and restricting the growth of business.

Consumers of world represented by concentric circles.

130. The consumers of the world may be divided into a series of concentric circles, each ring formed by those circles representing people of a certain purchasing power. The ring nearest the centre of the circles is necessarily the smallest, and contains just a few people of extreme wealth. It does not need much of an increase in the radius, to pass from the class having one purchasing power to the class having the next lower purchasing power; and as each increase in the radius is made, the area of the ring, and consequently the number of people in that class, increases out of all proportion to the number in the previous ring, until finally the outside ring is reached, which represents the people with the lowest purchasing power, who constitute the largest class of every community.

Object of commerce to reach widest class. Reduction in price brings article within wider circle.

131. The object of commerce—and railroad transportation is commerce—is to try and reach this widest class. Any increase in the volume of business reduces the cost of production per unit, as also the profit necessary on the sale of each unit to yield the same returns. Any reduction in prices will bring business within the reach of a wider range of consumers, and consequently permits of a further lowering of prices, or of the wages of the employees being raised, the surplus profits being used for this purpose instead of for reducing the price. Either result increases the demand, and, by increasing the output, still further reduces the cost per unit. Any improvement in the method of production further tends to lower the cost per unit, and every reduction of cost will bring the commodity within the purchasing capacity of an ever-widening ring of consumers.

Lowering of rates in America increased consumption generally.

132. This is what happened in America. Previous to the lowering of the rates by competition, consumption of many commodities was confined to a limited class of people, and to that class in a limited quantity. The lowering of rates brought these commodities, not only within the reach of a wider class of consumers, but enabled the previous consumers to increase their consumption.

To make rates pay, improved methods had to be devised. American rates lower now than those in any other country.

133. To restore the railways to solvency, it was not possible to put up the rates, even if this had been desirable with the experience before them, and the railway officials were forced to devise methods which would permit of their carrying the traffic at these low rates and at the same time earn a dividend for the stockholders. The alert American mind was not long in devising those methods, and to-day, railway rates for goods traffic, judged as a whole, are lower in America than in any other country in the world India not excepted, the average rate in 1902 per English ton of 2,240 lbs. per mile being in America 5·08 pies (12 pies = 1*d.* = 2 cents) as compared with the average rate for all India of 5·68 pies.

Railways in America taken as a whole yield same return as railways in India.

This is the average rate charged, not by railways which are in a state of insolvency, but by railways which, taken as a whole, are as prosperous as the railways in India. In 1902 the railways in India, taken collectively, yielded enough net earnings to pay a return of 4·92 per cent. on the total capitalisation.* The American railways in the same year yielded exactly the same amount, namely 4·92 per cent., on their total capitalisation,* notwithstanding the fact that they charged large—very large—sums to operating expenses, which in India would be charged to Capital.

Cause operating against America, large debenture stock paying high rates.

What operates against American railways is their enormous debenture and similar stock, on which high rates of interest have to be paid. Of a total capitalisation of $12,134,182,964, more than half, or the sum of $6,109,981,669, represents Bonds and like obligations. Of this latter sum, for 56·31 per cent., interest has to be paid to the holders at rates varying from 5 to over 10 per cent., and for 31·61 per cent. at rates of from 4 to 5 per cent.

American railways prosperous under low rates.

Nevertheless, many of the railways—a great many more than in India—earn enough from the low rates charged for freight to yield handsome returns to their *stock* holders. It is, however, by the net earnings, as unaffected by the adverse causes, that the low rates must be judged, and, as already stated, on the total capitalisation they yielded a return no lower than that earned by the railways of India.

Effect of low rates to increase enormously volume of business.

134. The effect of the low rates for freight has been to increase enormously the traffic of all the railways in America, as will be seen from the following statement in which I have included the corresponding figures for India to show the progress made there:—

Country.	Year.	Mileage operated.	Population.	Tons carried. (Tons of 2,240 lbs.)	Ton Miles (in millions of Ton Miles).	Average Rate charged per Ton of 2,240 lbs. per Mile.		Average moved per Cent. of Population.	
								Tons.	Ton Miles.
						Cents.	Pies.		
America	1890	157,976	62,947,714	617,271,819	70,986	1·04	6·24	987	111,100
	1900	191,862	75,994,575	956,582,070	123,899	0·84	5·04	1,259	162,300
India	1891	17,564	287,341,941	26,158,953	4,438	1·12	6·72	9	1,544
	1901	25,332	294,361,056	43,392,000	7,062	0·96	5·76	15	2,389

Prosperity of United States due to low rates.

135. The present prosperity of the United States of America is to no small extent due to the low rates charged for transportation. This prosperity has reflected itself in an increase of wages all round, which in its turn has increased consumption and consequently production. These high wages are

* The expression Capitalisation means, for India the actual cost of constructing the railways plus the premia paid by the Government in the purchase of such railways as have been acquired by the State, the outlay, on this basis, being Rs. 135,058 per mile of line open in 1902. For America, it means the Capital (Stock, Bonds and other securities) borne on the books of the several railways, and may represent a less sum than the actual outlay in constructing the railway, though in most cases it represents a great deal more. On this basis, the outlay was $59,930 or Rs. 179,790 per mile of line open in 1902.

not due to the necessaries of life *costing* the labouring classes in America more than they cost the same class in England. It is only the *style* of living which is better.

At the back of it all there is no doubt the Protective tariff, but that would have availed little without the cheapening of the cost of transportation.

Competition can be controlled in India. America not so protected.

136. I have dwelt at length on this question to show how, with the very best intentions, the judgment may be seriously at fault; and that hidden possibilities may lie in every undertaking, which may only be disclosed by the force of circumstances. In India, pooling and the territorial division of traffic are permitted and railways are not only allowed but are encouraged to protect themselves against competition. American railways enjoy no such protection, (any act which tends to restrict competition is illegal), but have been left to work out their own salvation as best they could. They have consequently been obliged to devote their efforts to reducing the cost of transportation, and the great bulk of the traffic can now be carried at rates which a few years ago were held to be impracticable and spelt bankruptcy.

Indian and American rates compared.

137. In paragraph 133, I said that the rates charged for goods traffic taken as a whole were lower in America than in India, not relatively but actually. When, however, the rates of individual railways are compared, it is found that with two exceptions, the Chesapeake and Ohio and the Pennsylvania Railroads, the average rate, taking the whole business done, is lower on the East Indian Railway than on any of the railways in America whose operations I examined, but that otherwise the average rates are generally lower on American railways than on Indian. The following statement will show this more clearly:—

Name of Railway.	Year.	Mileage operated.	Average Earnings per Mile per Week.	Tons carried (in thousands of 2,240 lbs.)	Average Earnings per Ton of 2,240 lbs. per Mile. (12 pies = 1*d.* = 2 cents.)	Average Distance each Ton carried.
American.			Rs.		Pies.	Miles.
Chesapeake and Ohio -	1903*	1,638	588	8,526	3·186	276
Pennsylvania Railroad -	1902	3,638	1,764	119,137	3·942	105
Pennsylvania Company -	1902	1,427	1,239	52,130	4·104	70
Illinois Central - -	1902	4,276	549	17,050	4·182	233
New York Central -	1903*	3,423	1,308	34,000	4·242	193
Pittsburg, Cincinatti, Chicago, and St. Louis.	1902	1,416	999	26,000	4·482	96
Philadelphia and Reading	1902	1,003	1,680	30,208	5·208	90
Great Northern - -	1903*	4,829	429	14,418	5·850	223
Chicago and North-Western.	1903*	6,332	450	27,188	5·880	132
Central of New Jersey -	1901	639	1,380	15,711	5·946	79
Southern - -	1903*	7,130	342	17,140	6·420	153
Chicago, St. Paul, Minneapolis, and Omaha.	1902	1,605	429	4,781	6·474	158
Indian.						
East Indian - -	1902	2,188	687	10,484	4·03	195
Bengal Nagpur -	1902	1,548	176	2,880	4·82	107
Oudh and Rohilkand (State).	1902	1,070	230	2,302	5·06	106
North-Western (State) -	1902	3,771	262	5,934	5·16	181
Bengal and North-Western.	1902	1,344	154	1,460	5·85	120
Great Indian Peninsula -	1902	2,717	378	4,627	5·87	272
Madras - - -	1902	1,387	229	2,319	6·22	126
Rajputana-Malwa -	1902	1,824	291	2,230	6·48	247
Southern Mahratta -	1902	1,646	109	1,016	6·76	157
Eastern Bengal State (5 ft. 6 in. gauge).	1902	274	728	1,800	7·86	87
Bombay, Baroda, and Central India.	1902	766	659	1,927	7·96	134

* These are for the year ending June 1903.

In preparing the foregoing statement, I have reduced the quantities to English tons of 2,240 lbs., and have taken one cent as equal to six pies, the ordinary equivalent of a penny being two cents.

Average rates for coal compared.

138. The only railways which show the average earnings per ton per mile from particular commodities are the Chesapeake and Ohio, and the Philadelphia and Reading Railroads, and they show them separately only for coal. Their figures compare with the great coal carrying railways of India, namely, the East Indian and the Bengal-Nagpur Railways, as follows:—

Railway.	Mileage operated.	Quantity of Coal in Tons of 2,240 lbs.	Average Rate per Mile per Ton of 2,240 lbs.
			Pies.
Chesapeake and Ohio - - -	1,638	3,871,000	2·23
Philadelphia and Reading - - -	1,003	15,553,041	4·36*
East Indian - - - -	2,188	5,042,000	3·63
Bengal-Nagpur - - - -	1,548	906,000	3·16

* The bulk of the coal carried by the Philadelphia and Reading Railway is anthracite coal, for which higher rates are always charged in America than for bituminous coal.

Position of Chesapeake and Ohio Railroad.

139. The position of the Chesapeake and Ohio Railroad which carries coal at these low rates is as follows:—

	$	c.
Its capital amounts to—Stock - -	60,539,500	00
,, ,, Bonds - -	73,651,354	17
Gross capital -	$134,190,854	17

or an average of over $81,000, or Rs. 243,000, per mile of line. Its net earnings, after freely charging to operating expenses expenditure which in India would have been charged to capital, were $5,185,147, or sufficient to pay a return of 3·9 per cent. interest on the gross capital. The Bonds and Car Trusts, however, absorbed $3,833,012, or a rate of interest averaging over 5 per cent.; and out of the balance, $664,305, or Rs. 1,992,915, were set aside for new equipment and improvements, after a dividend of 1 per cent. had been paid to the stockholders, it not being considered good policy to increase further an already overburdened capital account.

Although the Pennsylvania Railroad does not publish the average earnings from coal per ton mile, its rates for bituminous coal are governed by and are the same as those charged by the Chesapeake and Ohio Railroad. The bituminous coal carried by the Pennsylvania Railroad represents about 54 per cent. of the whole of its business. After freely charging betterments to working expenses, it earned enough to pay a dividend of over 12 per cent. on its gross capital, and it actually paid to its stockholders a dividend of six per cent., after keeping back *from the net earnings* over $13,000,000 for expenditure on betterments and new equipment.

Wholesale rates.

140. Turning now to details, in America railroad transportation is treated as an ordinary article of commerce, and in the sale of it, the same business principles are observed as obtain in all other branches of trade. Consequently there is a wholesale and a retail rate, and the difference between the two is as wide, and for the same reasons, as the difference between the wholesale and retail rates for any other article of commerce.

Taking first the wholesale rate, that is, the rate for traffic consigned in car load lots, the specific rates in America for grain and coal, the articles which, with seeds, constitute more than half the traffic on Indian railways, compare with the rates charged in India as follows. (*Note.*—In America the loading and unloading of the wagons is always done at the expense of the shipper.

In India, in the case of grain, it is done at the expense of the railway, and in the case of coal at the expense of the owner. In both countries the cartage to and from the railway is done at the expense of the shipper):—

Grain.

Railways.	Station.. From	Station.. To	Distance.	Per Ton of 2,240 lbs. per mile. 12 pies = 1*d.* = 2 cents.
				Pies.
India.				
North-Western	Delhi	Kurrachee	907	3·14
East Indian	,,	Howrah	954	2·92
Bombay, Baroda, and Central India.	,,	Bombay	888	3·22*
Great Indian Peninsula	*Viâ* Delhi	,,	981	2·91*
America.				
Export†	Chicago	New York	905	2·07
For domestic use	,,	,,	905	2·67
Export†	St. Louis	,,	1,047	2·11
For domestic use	,,	,,	1,047	2·69
India.				
East Indian	Moghal Sarai	Howrah	469	4·58
America.				
Export†	Buffalo	New York	410	1·86‡
For domestic use	,,	,,	410	2·72

* The *rates* are the same by both routes.

† The rate is the same by all routes, and by the longer routes works out to a lower average per ton per mile.

‡ This rate includes the placing of the grain alongside the steamer in the harbour. It has consequently to be transferred from wagons to a lighter, and taken by the lighter alongside the vessel. The cost of this service was estimated at 20 cents, or 120 pies per ton, which would reduce the average rate for the rail service to under 1·52 pies per ton per mile. The transfer from the lighter to the vessel is done at the expense of the shipper.

Coal (Bituminous).

Per ton of 2,240 lbs. per mile (12 pies = 1*d.* = 2 cents).

Distance.	Local, that is, not for Shipment. America.	Local, that is, not for Shipment. India.	Shipment. America.	Shipment. India.
	Pies.	Pies.	Pies.	Pies.
For 275 miles	3·16	3·26	2·58	†
,, 350 miles	3·06	3·15	2·64	
,, 420 miles	—	3·08	1·68	
,, 450 miles	2·94	3·05	2·58	
,, 478 miles	2·32	3·02	—	
,, 1,000 miles	*	2·73	*	

* I could obtain no rates for a distance of 1,000 miles, as I was informed that bituminous coal was not carried for greater distances than 450 miles.

† Special rates are not quoted for shipment coal, but a rebate, varying from 2½ to 15 per cent., subject to a limit in the gross of 10 per cent., is allowed off the local rates according to the quantity shipped.

Remarks as to coal rates.

141. In the case of coal, in India, the rates on all railways are calculated on a scale which is more or less universally applicable, the charge per mile decreasing with the distance. The rates quoted above are based on this scale, and are *at owner's risk*.

In America, there is not a scale of rates applicable to all railways, and the rates vary from time to time with general business conditions. The rates quoted above are specific rates, *at railway risk*, which were being charged on two railways at the time of my visit, and the rates on other railways conform with these rates.

Remarks as to grain rates.

142. In the case of the grain rates, it should be mentioned that there is canal competition between Buffalo and New York, but I have given the rates between these points to show at what rates traffic is carried at a profit in America. Since the opening of the season on 25th September 1903, an average of over 200 wagon loads of not less than 30 tons each were loaded daily at this rate on one railway alone.

In comparing the rates between Delhi and the ports in India with those from Chicago and St. Louis to New York (the rates to all other ports are based on the New York rate), I have selected the principal centres of distribution of grain in the two countries which are about the same distance from the ports of export. The rates for grain in the territory which lies west of the Mississipi river are somewhat higher than those prevailing east thereof.

Retail rates.

143. Taking next the retail rates, that is, the rates for traffic consigned in less-than-car-load lots, in America there are usually two sets of rates, one for traffic moving in the direction in which the bulk of the traffic moves, and another for traffic moving in the opposite direction, that is, in the direction in which empties move. In India, speaking generally, the same rates apply in both directions. In both countries the loading and unloading of wagons is done by the railway, and the cartage to and from the station by the shipper. In America small stations are grouped round a large station and the same rate charged to and from all in the group. In India, except in the case of competitive traffic, the rate is on a uniform mileage basis. In India, the same mileage rates apply more or less all over the country for traffic consigned in small lots. In America, the rates are generally lower in the east than in the west. In India, less-than-car-load traffic is carried by ordinary goods trains and is usually much longer in transit than traffic consigned in car-load lots. In America, less-than-car-load traffic is *always* conveyed by *fast trains*, and everything is done to expedite its movement because of the higher rate charged for it.

Rates for goods moving in direction of flow of traffic.

For goods moving to the east, that is, with the flow of the traffic, I was unfortunately unable to obtain the "Classification Rates" (*see* paragraph 160). But some specific rates on one railway for such traffic which were given me compare with the rates in India as follows :—

Rate in pies per ton of 2,240 lbs. per mile. (1 c.=6 pies).

Class.	India, irrespective of distance. *	America (Mileage Rate varies with Distance).		
		59 Miles.	107 Miles.	300 Miles.
1	27·22	38·71	31·40	14·33
2	22·68	34·11	27·62	12·99
3	18·14	18·63	20·09	8·51
4	13·61	18·22	18·84	7·61

* To the rates here shown there have to be added the terminal charges which vary on the several railways in India.

Rates for goods moving in direction of empty wagon movement.

For goods moving to the west, that is, with the flow of the empty wagons, the rates compare with the rates charged in India as follows :—

Rate in pies per ton of 2,240 lbs., per mile. (1 c.=6 pies.)

Country.	Highest Class.	Next.	Next.	Next.	Next.	Lowest.
America - - -	11·14	9·60	7·47	5·20	4·46	3·71
India† - - -	27·22	22·68	18·14	13·61	9·07	9·07

† To the rates shown there have to be added terminal charges which vary on the several railways in India.

144. There is a tendency in America for the rates for goods to advance, but the conditions there at present are somewhat abnormal and the rates will no doubt adjust themselves when the country steadies down again. The rates which I have quoted are those which were in force at the time of my visit, that is, during the abnormal period, when the tendency was for them to rise. They show that for traffic consigned *in less than wagon loads* for distances up to a little over 100 miles and *moving with the flow of the traffic*, the rate is much lower in India, but that otherwise *the rates charged in India are considerably higher than those charged in America*. In the case of the former, however, it has to be remembered that in return for the high rates charged, the traffic is carried by *fast* trains and the service is far superior to that given similar traffic in India. American rates lower.

But the wagon load traffic is the important traffic and represents the bulk of the business in both countries, and for traffic consigned in wagon loads the rates in India are usually higher than in America. Considering the conditions of the two countries, it would seem that they should be lower.

145. Railways cost more to construct in America than in India, and consequently need more net earnings to pay the same rate of dividend. American railways cost more to construct.

Working expenses also are higher in America because labour is very much dearer, as will be seen from the following figures:— Labour more expensive.

	$	Rs.	a.	
Enginemen—				
America - -	115·20*	or 345	8	per mensem.
India, European -	80·00	or 240	0	per mensem and less.
„ Native -	13·33	or 40	0	per mensem and less.
Firemen—				
America - -	66·00*	or 198	0	per mensem.
India, European -	30·00	or 90	0	per mensem and less.
„ Native -	5·00	or 15	0	per mensem and less.
Guards—				
America - -	96·30*	or 289	0	per mensem.
India, European -	50·00	or 150	0	per mensem and less.
„ Native -	16·60	or 50	0	per mensem and less.
Brakesmen—				
America - -	61·20*	or 184	0	per mensem.
India, Native -	6·16	or 20	0	per mensem and less.
Trackmen—				
America - -	37·50*	or 113	8	per mensem.
India - - -	2·00	or 6	0	per mensem with a maximum of about Rs. 8.

Note.—Overtime is paid in both countries; the bulk of the labour in India is Native; and in America the hours of work are shorter.

146. The prices of material, also, do not appear to be any less in America than in India, judging by the rate for rails, which in India at the present time cost about Rs. 82·8 a ton, as against $28 or Rs. 84 the price charged in America for home consumption; and by the price of coal, which in America is nearly Rs. 9 a ton, or more than the price paid by most of the railways in India. Prices of material.

147. Lastly, to go back to the theory of charging traffic what it will bear, the wage of an unskilled labourer *averages* for all parts of the States, $1·25, or 750 pies, or Rs. 3. 14. 6 *a day*. In India, the same class of man receives from two to four annas a day, that is, from Rs. 3. 12 to Rs. 7. 8 *a month*, assuming that he works every day. Theory of what traffic will bear applied to India.

This class represents the bulk of the population, and the business of a country must be influenced by the powers of consumption of the largest class. With a daily wage of two annas (2*d*. or 4 cents) a day (and all other

* These are averages for the whole of the United States. The wages in America are quoted at a daily rate, and the monthly rate has been arrived at by multiplying the average daily rate by 30.

labour is paid proportionately to this rate, the average for all classes in India being probably not more than Rs. 1, or 32 cents a day), the purchasing power is naturally very much limited, and if in America low rates have been found to be necessary to ensure a proper development of business, they would seem to be much more necessary in India to secure the same results, where not only the margin, but the whole sum available for expenditure by the multitude, is so small.

Grain traffic chiefly for export.

Causes affecting its expansion.

148. A great portion of the grain traffic moved in India is, however, for export, the cost of the transportation of which falls on the foreign consumer. He may be able to bear the rate, but India is not the only source of supply. While I was in America, the rate for grain was reduced from Buffalo to New York (and correspondingly to all other ports) from $4\frac{1}{2}$ to $3\frac{1}{2}$ cents. per bushel of 60 lbs., as the traffic could not be moved at the former rate. This reduction of 1/120ths of a penny per pound in the cost of rail transportation could not possibly have affected in any way the price of a penny loaf, yet without it, the traffic was at a standstill, and with it, some other market was shut out.

Grain rates from Delhi unchanged for 15 years.

In India, little attention is paid to the effect of rates on foreign markets, and I think I am right in saying that the grain rates from Delhi to the ports have not been changed for the past 15 years. The effect of this may be seen in the violent fluctuations which take place in the Indian wheat trade.

Indian wheat shipped dirty.

Otherwise not inferior to American.

149. A further cause operating against Indian wheat, is the condition in which it arrives in Europe. It has a considerable amount of dirt and extraneous matter mixed with it, and it is difficult to understand why the trade pay freight by rail and sea for the carriage of matter which has no value at the other end. The American wheat on the other hand arrives perfectly clean. I have the authority of a large grain merchant in Liverpool for saying that there is no very great difference between the *quality* of American and Indian wheat; and if the causes now operating against the latter could be remedied, there might be a very much larger business done.

Grain Elevators.

150. A still further cause, perhaps, which operates against the Indian wheat is the method of handling it. In America all grain is carried in bulk; and, to facilitate the handling of it, grain elevators are provided at all the grain-producing centres, and at all terminal points, for the storage of wheat, and for the loading of it into, and for unloading of it from wagons and steamers.

Wayside station elevators provided by private persons or companies.

At wayside stations these elevators are provided either by the grain merchants, or by grain elevator companies. The farmer brings the grain to the elevator, and the owner of the elevator grades it and pays for it at a rate which is usually slightly below the rate at Chicago, or the market with which the merchant deals. If the season at this market is favourable, the merchant moves the grain to it at once. Otherwise he keeps it stored in the elevator till a favourable opportunity offers.

At terminal points, elevators provided by railway always.

At terminal points the elevator is usually built and owned by the railway, so as to ensure the speedy release of wagons, but it is leased out to be worked, one of the conditions in the lease being that the lessee shall buy all grain which is brought into the terminus by the owning railway and which is not immediately sent forward to another market or diverted by purchasers to other elevators.

Method of dealing with grain at terminals.

On arrival at the terminal (this is the custom at Chicago, but I believe the same practice is followed at all terminal points), the wagons are opened by State Inspectors and the grain graded before the wagon is allowed to go to the elevator.

Immediately the grain has been transferred to the elevator, where it is stored according to grade, the owner is given a receipt in the form of a cheque which he presents at the office of the State Registrar for registration. After this has been done, the owner certifies on the back of the cheque that

the grain is stored in the elevator, and thereafter the cheque become as negotiable document on the Corn Exchange or elsewhere. When it is desired to draw out the grain from the elevator the owner of the cheque has to present it to the Registrar for cancellation, and, unless so cancelled, the elevator people will not surrender the corn, as they are held criminally liable if they do.

Capacity and cost of country elevators.

The country elevators are located at distances of from four to five miles apart, and vary in capacity from 7,000 to 150,000 bushels. A 7,000-bushel elevator which could lift about 2,000 bushels of grain per hour would cost complete about $3,000 or Rs. 9,000.

Capacity and cost of terminal elevators.

The terminal elevators vary in size, and a steel elevator with a capacity of 1,000,000 bushels (about 30,000 tons) of the most modern type costs about $350,000, or Rs. 1,050,000. In India they would probably cost a good deal less if made of brick and masonry.

Charge for storage.

The charge for the use of these terminal elevators, which includes storage, unloading from wagons and re-loading into wagons or steamers, for a bushel of wheat weighing 60 lbs. is as follows:—

First ten days, ·75 cent. or 4·50 pies.
Every day thereafter, ·066 cent or ·396 pie.

Cost of operation.

The cost of operating these elevators is generally considered to be covered by the amount realised from the sale of the screenings taken from the grain while in transit through the elevator, and the storage charge pays the interest on the investment, and provides the lessee's profit.

Advantages of elevators.

American railroad officials spoke with great enthusiasm about these elevators. By the carriage of grain in bulk and the use of elevators, the cost of the bagging and the freight thereon are saved, space is saved both in wagons and ships, and wagons can be handled expeditiously, and ships be loaded rapidly and at very little cost.

Possibility of introducing elevators in India.

I have made enquiries in England as to the possibility of introducing them into India, and I am told by those competent to speak, that though there might be difficulty in using elevators for the Calcutta and Bombay trade, as the quantity of wheat shipped from these places is comparatively small, they could with advantage be introduced for the Kurrachee trade.

Adaptable to seed traffic also.

They are capable of adaptation to the seed traffic as well, and much might be done to help the wheat and seed trade by the introduction of elevators into India. The cost of providing them would not be much greater than the sheds now provided at the ports for storing the bagged grain in, and the saving of time and expense in the handling of the traffic at the ports would be considerable.

Changes in wagons trifling.

The only changes which would be necessary in the wagons would be the provision of a moveable board to go across the doors, which could slide up over the door when the wagon was required for general use. This is how the American wagons used in the grain traffic are built.

In steamers none necessary.

So far as the steamers are concerned, I am informed that no change in their construction would be necessary in the case of the great majority of them.

Gunny bag traffic might suffer by introduction.

A large part of the traffic in gunny bags would, of course, be lost if elevators were adopted, but other uses would no doubt soon be found for them. In England these gunny bags fetch more than the wheat they contain, and value is attached to them, but they could be shipped there separately as gunny bags. Their carriage in bulk would probably cost less than it does at present when sent with the wheat, and the abandonment of their use would relieve the important wheat trade of all the expense connected with the purchase and carriage about India of them.

Question worth consideration.

I do not know whether the question of introducing elevators into India has ever been seriously considered, but if not, it might be examined now.

Coal elevators.

Incidentally, I may mention that elevators are also used for the coal traffic, where wagons cannot be brought alongside a vessel. They are fixed on barges and lift the coal from the coal barge, weigh it, and deposit it in the vessel.

151. In the foregoing remarks I have selected coal and grain to illustrate the position in India and America, as they comprise the bulk of the business in India. But the same remarks would apply to most other kinds of traffic *consigned in wagon loads.* The greater part of the American traffic is so carried because it is so much more cheaply and easily handled in car-load lots, and for traffic so consigned the rates will usually, if not always, be found lower in America than in India.

India, Position of, as to rates.

152. There must necessarily be differences in conditions in the two countries which would affect details to a greater or less extent; but taking the important factors which govern rates, in both countries the bulk of the business is in what may be termed car load lots, and the only difference is that there is more of it in America; in both countries the traffic is hauled for long distances and the only difference is that the average haul is longer in India, the figures for 1902 being,—

India	-	-	158 miles.
America	-	-	131 „

If, therefore, American railways find it profitable to carry goods at as low rates as they do charge for the bulk of their traffic, it would seem that the rates charged by Indian railways need re-consideration.

But, if any serious reduction in rates is to be made, such a reduction as may be expected to produce the results secured in America, the cost of *carrying* the traffic, that is to say the working expense account, would require to be considerably reduced. This can only be done by altered methods of working, such methods, *mutatis mutandis*, as have made it possible for American railways, notwithstanding the high wages they pay and the large amounts they spend in betterments out of operating expenses, to carry at a profit at the low rates they are now charging.

A low percentage of working expenses to gross earnings is not infrequently pointed to as evidence of the efficient and economical, and a high percentage as evidence of the inefficient or wasteful, management of a railway. A high percentage does not necessarily mean inefficient management. A low percentage *always* means a *wide* margin between the rate charged for the service, and the actual cost incurred in performing that service.

The percentage of working expenses to gross earnings in 1902, taking all the railways collectively, was in America, 64·66, as compared with 49·24 in India; yet the net earnings represented exactly the same percentage of the total capitalisation in both countries. At the same time the average rate charged for goods was lower in America, and it was because of this that the percentage was so much higher. These results do not seem to point to inefficient or wasteful management in America. On the contrary, they show that American railways make their income by small profits per unit and large volume, while Indian railways make their income by larger profits per unit and smaller volume. It seems scarcely necessary to suggest which policy is in the best interests of the railway itself or of the country. It is perhaps equally unnecessary to suggest that, from the shareholder's point of view, a low percentage of working expenses does not necessarily mean that he is getting the highest possible return from his investment.

Possibilities of expansion of traffic.

There are still over 90 millions of acres of "cultivable waste land other than fallow" available for cultivation in India, so that there would appear to be room for a large development of business.

Hay and fruit traffic.

153. Before leaving this question, I should like to mention that the fruit and hay traffic in America has, under fostering rates, assumed very large proportions.

Fruit.

154. The fruit, which is carried in refrigerator cars, is charged when consigned in wagon loads:—

Citrus—for a distance of 905 miles, 4·67 pies per ton per mile.
Bananas, for a distance of 912 miles, 6·50 pies per ton per mile.

The Banana traffic is offered in three or four train loads at a time, and its development to these proportions is, I was told, entirely due to the efforts made by the railway to give it cheap rates and quiek and safe transit.

The bananas are brought by fast steamers from the West India islands to New Orleans and other ports. At New Orleans, as soon as the steamer arrives (and it is not till it does arrive that the merchant is able to make any arrangements for the disposal of the fruit), the merchant telegraphs forward to all possible purchasers. Meanwhile the fruit is loaded up as expeditiously as possible and started off as "fast freight" as soon as the wagons are loaded, and without invoices. Before the trains reach the Ohio river, purchasers have been found, and telegraphic advice is then sent by, and at the cost of the railway, to the station staff at Cairo to divert the several wagons to their several destinations; and to the stations of destination, the particulars as to charges, &c. are similarly communicated. At Chicago, to which place a large part of the traffic goes, a shed to hold the wagons, with a cartway alongside, is provided for the banana traffic, and it is heated in the winter months to prevent the plantains being injured by frost.

Hay.

155. The hay is pressed in steam presses, the same as those used for cotton, and full loads can be obtained for a wagon. It is carried for distances over 1,000 miles, and the rate charged in wagon loads of not less than 10 tons for a distance of a thousand miles is 4·34 pies per ton per mile. For shorter distances, the rates are not much higher.

Cotton and Hay Presses.

For the pressing of the cotton and hay, the Planters Compress Company of Boston, Mass., have designed a press called the "Lowry Compress," which turns out cylindrical bales. The cotton bales turned out measure 36 ins. × 18 ins. and weigh 250 lbs., and the hay bales 33 ins. × 18 ins. weighing 220 lbs. The cotton is secured by flat bands, and the hay by wire. The cotton is further enclosed in a bag of coarse cloth, and when so pressed and packed is allowed 33 per cent. lower rates from steamer companies, and 45 per cent. lower rates from Marine Insurance Companies, than the ordinary square pressed bales. The railways at present make no difference in their rates. The machinery is served from above, and the fibre or blade of grass lies lengthwise in the bale. It is claimed that this prevents all damage to the article, and that the circular bales are easier to handle than the square bales, and load better into wagons. The presses cost $ 4,500 or Rs. 13,500 f.o.b. New York without belting and boiler. They are usually put up in connection with the Ginning Mills, and the same power which works the latter is used to work the Press.

Also used for compressing old tin cans, &c.

The same Press, only built a little stronger, is also used for compressing tin scraps (old tins and cans), to facilitate their transportation to places where they are again melted down and worked up into tin sheets.

CLASSIFICATION OF GOODS.

Classification of goods.

156. For purposes of classification, the United States of America are divided into three distinct groups, the reason for this being that the conditions in the different areas are not the same, and a classification which might be suitable in one area would be totally unsuitable in another.

These areas and the classifications applicable to them are as follows:—

East of the Mississippi and north of the Ohio rivers - - - -	Official Classification.
West of the Mississipi river - -	Western Classification.
South of the Ohio river - - -	Southern Classification.

Classification varies in each group.

These classifications vary not only as to the goods but as to the number of classes in which they are subdivided. Under the Official classification there are six classes; under the Western, five; and under the Southern, six.

Classification Committee.

157. These several classifications were drawn up by Committees of Traffic Managers, which committees have since become permanent bodies under the name of Classification Committees. They consist of 16 members, each representing a different section of the country, and they meet twice a year, when all general questions relating to classification are referred to, and dealt with, by them.

Committee's powers recommendatory.

158. The Committee's powers are only recommendatory, but I was informed that it was very rare for the decisions which they had arrived at to be overruled by the railway administrations. The principle is very thoroughly recognised in America that it is not much use referring a question to a body of conscientious experts, and then subjecting its conclusions to the judgment of an individual, who is no more competent perhaps than any member of the Committee to offer an opinion, and who has not had the advantage of being present at the discussion of the subject, and could not consider the many aspects which every question must present, and which could only be brought out in a discussion such as would take place at a meeting of a large body of men representing varied interests.

Open to an individual railway to object.

159. Where, however, the conclusion arrived at affects very seriously the interests of a particular railway, that railway may object to adopt the proposal, and the item is then struck out; but each railway's interests are represented on the Committee, and as the Committee strive to be fair to all, it is rare even for an individual objection to be made.

QUOTATION OF RATES.

Classification Committee also fixes rates. Tariffs simple.

160. The Classification Committee not only makes the classification, but it also fixes the rates for all traffic passing over two or more railways which is not carried under special rates and which is not competitive. The method here adopted is simple, and avoids those terrible goods tariffs which have become a perfect nightmare to everyone who has anything to do with them in India.

Method adopted.

The arrangement is as follows:—

Certain representative stations in the area are taken, and round them are grouped the smaller stations in the neighbourhood. Two representative points are then selected for the standard, which is 100, and forms the basis of all the rates. For the official or eastern classification, the stations selected for the standard are New York and Chicago, and the rate basis from New York to Chicago is 100, the rates in cents per 100 lbs. for traffic moving to the west (I was unable to obtain the information for traffic moving east) being, —first class 75, second 65, third 50, fourth 35, fifth 30, and sixth 25. All stations in the New York group charge these rates to Chicago.

Besides the New York-Chicago basis, there are several other stations, the rates from each of which are proportional to the distance from New York to Chicago, and are represented by a percentage of the New York-Chicago rate.

All the stations in the area are shown, first with their rate basis, that is, under the station round which they are grouped, and next with the percentage which is to be charged.

To ascertain the rate chargeable from a town in the east to a town within the area in the west, all, then, that has to be done is to find the rate basis

applying from the point of origin, and next to ascertain the percentage basis applying to the western point. A reference to the corresponding rate basis in the table of rates will give the rate to be charged. All rates cover the entire distance, and are not local to each railway.

Division of rates between railways.

161. The Classification Committee also decide how the rate is to be divided between the railways performing the service. Where there is no special reason against this, the division is in mileage proportion. Otherwise, what are called "arbitraries" are allowed. The following extract from the rate book will, perhaps, make this point clearer:—

"Arbitraries to be allowed the N.Y., N.H., and H.R.R.

"The following arbitraries are to be deducted from through rates and "allowed to the N.Y., N.H. and H.R.R. as that Company's pro- "portion to New York City, including transfer to N.Y.C. and "H.R.R.R.:—

"From Boston, Mass. (Proper).

"*In cents per* 100 *lbs.*)

Classes.	1	2	2 Less 15 Per Cent.	3	3 Less 20 Per Cent.	4
To New York - -	16·9	14·2	11·6	10·2	7·6	6.3
Transfer - - -	3·0	3·0	3·0	3·0	3·0	3·0
Total - -	19·9	17·2	14·6	13·2	10·6	9·3

"From Stations other than Boston.

"*In cents. per* 100 *lbs.*

Classes.	1	2	2 Less 15 Per Cent.	3	3 Less 20 Per Cent.	4
To New York - -	20	17	14	12	9	8
Transfer - - -	3	3	3	3	3	3
Total - -	23	20	17	15	12	11

"Balance of through rates will be divided on Current Line or Road "percentages applicable from New York City."

Traffic in wagon loads encouraged and rates quoted therefor.

162. In America, the conveyance of traffic in wagon loads is encouraged as it not only saves the railway the labour of handling, but ensures a reasonable load to the wagon. A wagon load rate is always, therefore, given for all traffic likely to offer in such quantities. For traffic moving under normal conditions, that is, for which no special rates are quoted and which is not competitive, the wagon load rate is secured by classification, and the Classification Committee in preparing the classification say under which class the commodity shall be charged when in car load (C. L.) lots, and when in less than car load (L.C.L.) lots. The difference in charges is generally two classes, that is, if L.C.L. traffic is classified 1st Class, C.L. would be classified 3rd class.

Loads only required up to a percentage of capacity.

Loads up to the full carrying capacity are never demanded, but a reasonable percentage of that load only is required to secure the car load rates. The minimum weight varies according to the nature of the traffic, but the charge is made on the actual weight loaded, subject of course to the minimum. As a consequence of the favourable rates allowed to traffic in car loads, the larger part of the business is consigned in car load lots. The advantages of this to the railway are obvious, and trade has not been found to suffer in any way by the arrangement.

For special traffic there are special tariffs.

163. For all special traffic, that is, traffic offered in large quanties, such as the different kinds of coal, grain, cotton, and so on, special tariffs, dealing with the particular commodity only, are issued by the railway on which the traffic originates.

The rates for these commodities cover the whole distance whether the station of destination be on a foreign road or not, and I was assured that the *rates were generally fixed by the railway on which the traffic originated without the railway on to which it was going, being consulted at all.* I expressed surprise at this arrangement, and was told that the railways were only too glad to get the traffic and were quite satisfied that the railway fixing the rate was doing the best that was possible. Rates thus quoted were rarely objected to, for the simple reason that if one railway objected, there were others who would be willing to take the traffic on the same terms.

Originating railway quotes rates for through distance.

164. As I explained when dealing with the question of organisation of American railways, the Traffic Officers are men whose sole business is the solicitation of traffic and the fixing of rates which will make that traffic move. They spend the whole of their time travelling about the country with this object, and all railways recognise that a rate which is good enough for the railway on which the traffic originates is good enough for them. Where the circumstances on any railway are different and call for special consideration, this is always conceded by allowing "arbitraries" in the division of the rate. The procedure thus followed saves a great deal of time and trouble and prevents traffic being lost through the delays which would follow lengthened negotiations with the railway on to which the traffic was going. It certainly is simple. It has been found to work very well and is generally recognised as a perfectly satisfactory arrangement, in fact, as the only practical arrangement in the interests of all concerned.

Value of Traffic Officers.

The force of Traffic Officers is strong and capable, and their attentions are not confined to America alone. They are in constant touch with shippers and they watch the foreign markets; and where changes in rates are necessary to secure business, they are not slow to make them in combination with the steamer companies or by themselves. It is through the agency of these Traffic Officers that markets are now being opened up for American products in China and Australia in competition with European markets, and I was told of more rates than one which had lately been introduced with this object.

No corresponding machinery in India.

In India, there is no such machinery. The officer doing the work of the Traffic or Commercial Department is also looking after the Operating Department. He cannot, therefore, devote all his time and energies to either, and in consequence the best results can never be obtained.

CHAPTER V.

TRAIN LOADS.

LOADS OF TRAINS.

Low cost due to heavier engines and vehicles.

165. All that has made the low rates now charged for goods in America profitable is the low cost of operation per ton per mile, and the low cost has chiefly been secured by increasing the carrying capacity of wagons and the hauling power of engines.

Bogie type of car adopted generally. Reasons therefor.

When the bogie truck was first invented, its great value was realised in America, and it gradually displaced the four-wheeler, until now very few of these latter exist on any railway, and these few are only used for special local purposes and are never allowed off the home line and are seldom allowed on to the main line.

The methods adopted to get over the break of gauge difficulty showed what the possibilities were in regard to the loads which might be placed in a wagon; and, when the strain of competition forced railways into devising means for mitigating its consequences, the step taken was to increase the weight in the car and the load behind the engine.

The beneficial effects of these measures were immediately reflected in the statistics of operation, and the policy was then inaugurated which has led to the heavy wagons and heavy engines now in use on American railways.

As each new type of wagon and each new type of engine was brought into use, scientific experiments were made in connection with them and much valuable information obtained.

Results of experiments.

166. In the latest of these experiments it was found that the resistance for each ton moved diminished with the increase of the gross weight of a vehicle. *This was definitety shown time and again*, not only by the increased tonnage which a given locomotive would haul over the ruling gradient on the engine's run when the said tonnage was in a few cars of large capacity, but also by accurate and extensive tests made with the dynamometer car.

Hauling capacity of engine governed by dynamic and not by static force.

The indications from these tests were that the resistance per ton hauled was governed by the gross load per axle, and that the pounds pull per ton diminished with each increase of load in the vehicle. In other words, that it was the dynamic and not the static force which really governed the hauling capacity of an engine; and that while the ratio between the tare and the load must always be an important factor, its importance diminishes as the number of vehicles over which the tare and the load are distributed increases.

As a concrete example, the resistance of light empty cars weighing about 24,000 lbs. each, was found to be in the neighbourhood of 7½ lbs. per ton at a speed of about 12 miles an hour, while the heavier car weighing 150,000 lbs. loaded, gave a draw bar pull as low as 2·2 lbs. per ton. Both these figures are corrected for grade (the ruling grade of the District on which the tests were made) and for acceleration, and represent the force required to maintain the cars in motion at the speed given. It was, however, also found that, as the correction for the grade component is directly as the weight and the grade, the disproportion between the hauling power of the two classes of vehicles diminished rapidly with the increase of grade and tended towards an equality on steep grades. But as steep grades are not usually met with, except for very limited distances, the advantages are considered to be entirely with the heavier vehicle.

Wind resistance not calculable.

The experiments producing these results were made under all the varying conditions of wind and weather, but very little accurate information could be obtained in regard to wind resistance. While it is recognised that winds,

especially quartering head winds, have a very material effect on high speed passenger trains, it has so far never been found possible to apply to the dynamometer car, apparatus for measuring the direction or force of wind, chiefly for the reason that the atmosphere in the neighbourhood of a moving train was too much disturbed to afford means for any reliable measurements. But there are collateral data which show that the wind resistance with short trains is a very much larger factor than with long ones, indicating that the head and rear resistance are the more important ones.

But believed to adversely affect short trains.

As already stated, however, the experiments were made under all conditions, and the results, therefore, include the effects of wind resistance.

Fewer the vehicles in which load concentrated, greater the load hauled.

167. The practical lesson learnt from these tests was—

First, that it is the number of vehicles in a train which is the important factor in governing the load which the engine can haul. The more the load is concentrated, that is, the fewer the vehicles in which the load is placed, the smaller proportionally will be the draw bar-pull, and the greater the load which the engine can haul without increased strain or expense. Consequently, an improvement in the proportion between the tare and carrying capacity of a vehicle is not sufficient. It is the number of vehicles carrying the load which requires to be reduced for the best results to be produced.

Draw-bar-pull only economical basis.

Secondly, that the tonnage basis of computing the load does not ensure the engine being worked to its full capacity, and that the draw-bar-pull is the only economical basis of computation.

Advantages of heavier cars as shown by draw-bar-pull.

168. To make the advantages of this system clearer, I have taken the following example from the working schedule of the division where I found it in operation. The draw-bar-pull, which, as already explained, is based on the ruling gradient in the engine's run, for a wagon weighing with its load 24 tons (this is the weight of the new type of coal wagon being introduced on the East Indian Railway, namely, tare 7 tons, carrying capacity 17 tons), is 192 lbs. The draw-bar-pull of two such cars weighing in the gross 48 tons would, therefore, be 384 lbs. The draw-bar-pull of *one* car weighing in the gross 48 tons is *only 283 lbs.*, and that of *one* car weighing in the gross 67 tons (the 50 ton cars with a tare of 16·30 tons and a carrying capacity of 50 tons) is *only 366 lbs.*

Illustration of effect.

The effect of this on the load of the train will be seen from the following :—

Draw-bar-pull of Engine, 16,000 lbs.

Train of Cars weighing in Gross.	Draw-bar-pull of each in lbs.	Number of Cars required to make up Load.	Dead Weight in Train in Tons of 2,240 lbs.	Paying Load in Train in Tons of 2,240 lbs.	Gross Weight of Train in Tons of 2,240 lbs.
24 tons (tare 7 tons) -	192	83*	581	1,411	1,992
48 tons (tare 14 tons) -	283	56†	784	1,904	2,688
67 tons (tare 16·30 tons)	366	43‡	701	2,150	2,851

* There are 64 lbs. to spare.
† There are 152 lbs. to spare.
‡ There are 262 lbs. to spare.

Heavier wagons yield more paying load and allow engine to haul more.

169. In other words, both practical and theoretical tests have shown that if the load of three 17 ton wagons is concentrated in one 51 ton wagon, there is not only a saving in the dead weight hauled, but there is a saving of over 43 per cent. in the demand made on the engine, and the engine can haul 53 per cent. more of paying load without any increased effort or expense. It would seem, therefore, that the best results can only be obtained by concentrating the load in as few vehicles as possible.

Practical demonstration of this.

170. As a specific illustration of this, I was told that when the steel or 50 ton cars were first introduced, (they preceded the heavier type of engine), the average load of a train on this division with a given gross tonnage, was 57 cars. The same gross tonnage could be carried in 32 steel cars, but upon trial, it was found that the same engine could haul 38 steel cars as easily as it formerly hauled the 57 lighter capacity cars. *The same engine consequently moved 300 additional tons of paying freight without any extra cost to the railway.*

Railways replacing light by heavy cars, because of great advantage of latter.

171. With the heavier type of engine now introduced, the benefits derived by the employment of heavy cars became still more marked. The great saving of standing room which they make possible is also a very important factor; and the conclusion arrived at in America is that anything which will increase the transportation efficiency of the service without requiring increase of track accommodation on the line and at stations is clear gain; and so satisfied are the authorities with the results which have been obtained by their acting on this conclusion, that all light cars and light engines are being replaced as fast as possible by heavy cars and heavy engines. Indeed, one railway has gone so far as to refuse from foreign roads cars of 15 tons capacity and less, because of their poor loading and because they inordinately increase the length of the train and add to the difficulties and danger of handling it. All the reports one hears of couplings breaking, "ends torn out," &c., are due to these light types of vehicle. They were built to bear a certain strain, and when subjected to the far greater strain of the present heavy train loads, it is not surprising that they do fail.

Seventy engines now being built with capacity of 8,000 tons on level.

Another railway has just placed an order with the Baldwin Locomotive Works for 70 engines which I saw under construction, and which are to be 15 feet 6 inches from rail to top of stack and 10 feet 6 inches wide over cylinders. On a conservative basis, these engines are estimated to haul a load of over 8,000 tons on the level and over 3,000 tons on a half per cent. grade, an estimate which it is expected will be exceeded in actual practice.

Effect of traffic in small lots, how overcome.

172. The difficulties connected with the traffic in small volume to and from the small towns are not absent in America, as will be seen from the particulars mentioned in paragraph 305; but they have been overcome in the manner explained in that and the preceding paragraphs, and by requiring light loads from wayside stations to be sent to the first transhipping station to be made up there into suitable wagon loads. The minimum load which *may* be given to a wagon is $2\frac{1}{2}$ tons, but as a general rule wagons travelling with the flow of the traffic are only permitted to be sent through to destination with a minimum load of 5 tons. The rates for less-than-car load traffic being as high as they are, the loss in loading is usually compensated for by the higher revenue earned, and I was assured that on very carefully going into the question, the railway authorities were satisfied that if only 10 per cent. of their whole business could be carried *in full car loads*, it paid to have 50 ton cars.

50-ton vehicle economical if 10 per cent. of business carried in them.

This statement, which at first sight appears incredible, would appear to be not improbable for the following reasons :—

(i.) The great bulk of the traffic on American railways is consigned in car-load lots, and only a small proportion of it is consigned in small lots.

(ii.) To obtain the benefit of the car-load rate, it is not necessary to load up to the full capacity of the wagon. The minimum weight to which the rate applies varies with the nature of the traffic; but where the wagon is capable of taking a full load, the minimum is usually fixed at one ton less than the carrying capacity. Thus, for coal, the minimum weight for a 50-ton car is 49 tons, and for a 20-ton car 19 tons. Consequently, a potential capacity of 50 tons, when only the minimum load is obtained, yields revenue on $1\frac{1}{2}$ tons more when the load is in a 50-ton car, than when it is in 20-ton cars.

(iii.) The load when concentrated in a 50-ton car gives a better load behind the engine than is possible when the same load is distributed over 20-ton cars, *vide* paragraphs 168 to 170.

(iv.) Consequently engine mileage is saved in both directions, as also vehicle mileage.

(v.) Fewer engines and vehicles are needed to move the same volume of traffic, and saving is effected in cost of equipment (a 50-ton vehicle costs less than its equivalent in 20-ton vehicles), and in its subsequent maintenance.

(vi.) Fifty-ton vehicles need less standing room at stations and at terminals than their equivalent in vehicles of lower capacity, and save outlay on siding accommodation and the cost of maintaining the same.

Shunting difficulty overcome by pinch bars.

173. An objection which has been advanced against these heavy cars is the difficulty connected with the handling of them at wayside stations and in goods yards. This difficulty also was not absent in America, and it was much more important there, when it is remembered that the daily wage for unskilled labour averages $1·25 or Rs. 3. 14. 6 a day. It has been overcome by the invention of pinch-bars of various kinds for facilitating the movement of cars by hand shunting. There are several of these devices on the market and I was told that they were perfectly effective.

174. When saying that engines and wagons of the light type are being replaced as fast as possible, I don't mean it to be understood that every railway is throwing these types of stock on to the scrap heap as fast as they can. What they are doing is to scrap all light stock which requires more than a very limited amount to be spent on its repairs, to build no new stock except of the heavier type, and to lose no opportunity of getting the heavier type on to the road.

Economies resulting from use of heavy wagon and engine.

175. The heavy wagon and engine have been in use in America only a few years. During this time, the railways have enjoyed a period of prosperity, and large expenditure has been incurred in betterments and on new equipment, part of which has been paid for out of capital, part out of profits and part out of working expenses. The portion charged to working expenses has not been separately shown, but has been merged with the ordinary expenditure actually necessary for the operation of the railway. It was not, therefore, possible to prove by definite figures that the introduction of the heavy car and engine has been productive of economy in maintenance of roadway and equipment. But it is believed that direct economies could be shown if an entire separation of the unusual charges were made in the accounts, and this view seems to be borne out by the fact that during the past ten years there has been a fall in the percentage of working expenses to gross earnings of from 66·67 per cent. in 1892 to 64·66 per cent. in 1902, notwithstanding the fact that during the same period the charge made to the public has fallen, that for passengers from 2·126 to 1·986 cents per passenger per mile, and that for goods from 1·005 to ·847 cent per ton of 2,240 lbs. per mile.

Heavy engines considered economical.

There was one point, however, which was regarded as important, and that was, that these heavy engines are shopped more frequently than the lighter ones. As far as running repairs are concerned, the former have to be shopped every eight or nine months, while the latter run comfortably for twelve months. Notwithstanding this, the introduction of the heavy engine is regarded as economical as compared with the lighter type, and, as already stated, every railway is increasing its supply of them.

176. Engines of the heaviest type would be most uneconomical if they could not be loaded up to their full capacity. In India, on most of the main lines, the traffic is heavy enough to ensure such engines getting full loads at all times of the year. On lines with a low volume of traffic, or with less constant business, and on branch lines with light traffic their use would be wasteful; but in most places a heavier type of engine could be beneficially adopted, and the introduction of the heaviest type, wherever circumstances justify, could only be productive of good results.

India—applicability of heavy engines to.

Very heavy engines uneconomical unless given full loads.

Unsuitable on lines with little traffic.

The average load now obtained *per* goods train on one railway in America, taking into account fast and slow trains, main line and branch traffic, is as high as 518 tons per train mile run, while in India the best average obtained last year was on one railway 245 tons, and on none of the others more than 200 tons.

Steady progress is being made on all railways in America to increase the load in trains, and when the heaviest type of engine has been more generally introduced—at present there are not many of them—the average load hauled will be considerably increased. In India, while progress has been made by some railways, the improvement has not been very marked.

The following statement shows what has been done in the two countries. I have only been able to give information for a few of the American railways, and in their case for only a limited period, as it is only during the last few years that statistics have been kept by most of the railways in the detail in which they are now prepared :—

Railway.	Average Load of Train.			
	Year.	Tons.	Year.	Tons.
India.				
East Indian	1890	202·22	1902	195·95
Great Indian Peninsula	1890	109·59	1902	153·30
North Western (State)	1890	116·78	1902	150·95
Oudh and Rohilkand (State)	1890	108·46	1902	123·63
Bombay, Baroda, and Central India	1890	174·34	1902	245·05
Madras	1890	100·14	1902	113·42
America.				
Pennsylvania	1895	332	1902	518
Illinois Central	1890	129	1903	288
Central Railroad of New Jersey	1897	240·4	1901	470·9
New York Central and Hudson River	1890	246	1903	368
Great Northern	1890	196·7	1903	446·78
For all American railways taken collectively.	1890	163·99	1902	308·19

177. Similarly with regard to the 50 ton vehicle, its introduction is only of recent date, and in 1902 there were only 48,834 of this type out of a total of 1,546,101 goods wagons in America. Of this latter number, however, no less than 864,442, or over 57 per cent., had a capacity of 30 tons and over, and it is to the vehicles of the 30 and 40-ton type, coupled with the heavier engine, that the low cost of carriage per ton per mile is due.

India—position of, in regard to heavy loads.

The 50 ton vehicle and the Mammoth engines will still further reduce this cost, but up to the present they form so small a proportion of any railway's equipment, that the benefit of them has not yet been appreciably felt.

The heavier engine was only made practicable by the concentration of the load in as few vehicles as possible. It was impossible with the lighter type of vehicle, as, apart from the great loss sustained in the weight the engine could haul by the load being scattered over many units, the train became too long and unwieldy, both for efficient control when running and for the sidings along the line. All American railways are, therefore, getting rid of

the lighter types of vehicles as fast as possible, and the progress they are making in this direction may be gathered from the following figures :—

Railway.	Year.	No. of Freight Cars on Line.	Average capacity of each Car.
			Tons.
Pennsylvania Railroad	1899	52,712	26·6
	1902	59,574	29·5
New York Central Railroad	1901	61,855	27·75
	1902	63,542	28·75
Illinois Central Railroad	1901	37,908	29·43
	1903	51,319	32·87

In a very few years there will be no wagons left of a less capacity than 30 tons.

Such loads would not be possible in any but the bogie type of wagon, and that is the type universally used in America.

In India bogie wagons are almost conspicuous by their absence on the 5 ft. 6 in. gauge lines, and a prejudice has been growing up against them on the metre gauge lines. The whole experience of America is in favour of them and the results obtained there are so extremely satisfactory that it would seem desirable that the railways in India should re-consider their position in regard to them.

As has been shown in a previous chapter, their adoption would help to mitigate, if not overcome, the break of gauge difficulty, and their introduction, even without an increase of weight on the axle beyond that now permitted, would render possible large economies in the cost of operation.

That the introduction of the heavier type of engine and vehicle has been productive of the best results for America may be judged by the greatly improved financial condition of all the railways in that country, and by the prosperous condition of the railways which have been able to introduce them the most extensively, notwithstanding the fact that they have all spent very large sums of money both out of operating expenses and out of capital to make their roads fitted for the heavier loads.

OUTLAY TO SECURE HEAVY LOADS.

Introduction of heavier equipment necessitated considerable changes in structures and roadway.

178. Of course, these heavy engines and heavy wagons were not introduced without considerable changes in roadway. The increase in the size of the equipment involved an increase in running dimensions of numerous structures, such as Engine Shed (Round House) openings, Coaling Station clearances, and, in some cases, tunnels. The increase in the weight of the equipment made it necessary to re-design many of the structures, notably turn-tables which have had to be increased in length and made stronger, weigh bridges which have had to be replaced, bridges which have had to be strengthened or completely rebuilt, and roadside stations which have had to be changed. The shop facilities for both cars and engines had also to be almost entirely revised, and all loading and unloading platforms and wharves had to be re-constructed. Rails and sleepers also have in some cases been strengthened, but this is not usually done until renewals in the ordinary course are necessary.

No small part of this expense has, in many cases, had to be incurred twice over, as it had to be incurred when the 40 ton vehicle was introduced, and again for the 50 ton vehicle, which, when the first change was made, was not considered to be physically practicable.

Private owners made to conform with wishes of railway.

179. The changes which required to be made were not confined to the railway. Every industry of any consequence had its own sidings, weigh bridges, loading and unloading wharves, &c., and a good deal of opposition was met with from the owners of these to the changes which the introduction of the heavier equipment necessitated. But it was not permitted to turn the

railway management aside from their purpose, and steps were taken to make private, that is, non-railway owners conform with the plans which were conceived for the welfare of the railway, but were recognised as being for the benefit of the trade of the country generally.

Change in grading and alignment often found necessary.

180. Often the road had been found to limit the loads of trains, through the line having been badly laid out. Where the difficulty could be overcome by slicing off humps, or filling in hollows, or by straightening out curves, this has been done; but where any or all of these expedients were found to be insufficient, the alignment has been altered, the change not being limited to short lengths only. For example, in the last six years, one company has relaid on an entirely new alignment, no less than 216 miles of its railway, abandoning the old line, so as to reduce grades and curves; another has 93 miles of double line now under construction with the same object; and all railways are working in this direction.

Road is made to fit vehicle and not vehicle to fit the road.

181. To do all this an enormous outlay has been necessary, but in America the view is very strongly held that the road must be made to fit the vehicle, and not the vehicle to fit the road. It is recognised that cheap rates are impracticable without low cost of transportation per unit; that low cost cannot be obtained without large train loads; and that the largest train loads cannot be obtained with heavy grades and sharp curves, or without large wagons. The aim is to get the largest possible train load which the physical conditions of the country, as improved by the skill of man, will permit; and to secure this object no expense is spared which will enable the railway to put into service the most powerful equipment which the ingenuity of man can design. Though the expenditure thus incurred may appear extravagant, it is regarded as economical extravagance.

Expenditure incurred charged as far as possible to Operating Expenses.

182. In incurring this expenditure it has been realised that to charge it all to Capital would only cripple the railway later on. A large, often a larger, portion of it, therefore, has been charged against Revenue, that is, operating expenses or profits. At first, shareholders protested against this practice, but it is now generally accepted as wise. Efforts are made to keep the amount of the dividend constant, and anything which is earned over and above the sum which will do this is put into the road. Much of the money so spent has been charged directly to operating expenses, and is not now separable therefrom; but the greater part of it is shown separately in the published accounts.

One prominent American railroad had taken out for me the expenditure which it had incurred in strengthening bridges and road bed over a length of 440 miles, and the amount comes to $5,500,000·00, or $12,500·00 per mile. To secure the heavier loads and generally in improving the property, the Pennsylvania Railroad has, in the last five years spent over $47,000,000 out of revenue and $13,000,000 out of capital, or a total of $60,000,000, or an average of $12,000,000 a year, and the New York Central during the past three years has spent $12,000,000 out of revenue and over $15,000,000 out of capital, or a total of $27,000,000 or an average of $9,000,000 a year. In other words, these two railways aggregating a trifle over 7,000 miles of line have, between them, spent an average of $21,000,000 or Rs. 63,000,000 a year to provide the heavier equipment considered nccessary for really economical working and to make the road suitable for this heavier equipment.

India—expenditure not large compared with that incurred in America.

183. In India the Government have pursued the same policy of paying for new works partly out of Revenue (the surplus revenue accruing to the State from railways being devoted to this purpose), and partly from capital, that is, from borrowed money; but the total expenditure which has been incurred in rolling stock and improvements on the 20,474 miles of railways, for which the Government are financially responsible, has, for the past three years, not exceeded Rs. 42,000,000 a year; that is to say, two private corporations in America have deemed it in the interests of their property to spend annually Rs. 63,000,000 a year on 7,000 miles of line, while not two

thirds of that amount has been considered sufficient in India for a mileage nearly three times as great.

India—what she can do to adopt heavy loads.

184. India would not require to spend money on anything like the same scale as America to enable her railways to carry the same loads as are now being taken by goods trains and vehicles in America. Her railways were originally constructed up to a much higher standard than American railways, and the road bed in India is in every respect as strong as the road beds in America, over which these heavy loads are now being run. Her bridges would need strengthening for the heavier type of engine, though here too I am informed by expert engineers that there would be no need to incur large expenditure *before* a change in the load of trains is made. But even if the bridges must be strengthened before heavy engines are allowed to pass over them, it was considered sound policy in America to *re-build* all bridges (many of them more than once), and subsequent events have proved the wisdom of the policy.

The introduction of the heavier wagon by itself, however, would not necessitate any change either in the roadway or bridges, and the economy which would result from this measure alone may be seen from the figures given in paragraphs 168 and 170.

WATER TROUGHS.

Engines and vehicles only earning money when wheels are going round.

185. In the effort to reduce the cost of transportation, the importance of not keeping engines and vehicles standing idle is always kept in view. It is realised that *they are only earning money when the wheels are going round;* that when they are permitted to remain idle a minute longer than is absolutely necessary, that is, when they are not being made to do as much work as they are capable of doing, they are not only not earning money, but are causing avoidable expenditure. Any needless delay to them involves the provision of a larger number of engines and wagons for the transportation of the same volume of traffic, as also lines for these extra engines and vehicles to stand on, together with the attendant expenses of maintenance and renewal of both equipment and sidings.

Water-troughs.

186. To minimise the unnecessary standing idle of vehicles, water troughs are being provided in substitution of water columns, and *goods* trains now pick up water as they are running in the same way as passenger trains do. The time occupied in taking water from the ordinary water column amounts each time to from five to ten minutes, so that an appreciable amount of time is thus saved on a long journey, and a waggon is able to make several more trips in the course of a year.

187. The average daily mileage run by wagons in America would seem to indicate that in practice very little was done to keep the wheels of the wagons going round. That the average is as low as it is, is due to three causes, namely:—

(i.) America has a busy season, which is confined to a few months, and a supply of stock has to be maintained for this busy season, for which during a large part of the year there is no use.

(ii.) Under the laws of the country, four days free time is allowed to all consignees, and as the bulk of the traffic is car load traffic, and until recently the free allowance was taken full advantage of, the delay at terminals necessarily pulls down the average.

(iii.) The rules under which rolling stock was interchanged with foreign railways.

The first two of these causes are beyond the control of the railways. The last has only recently been met by requiring payment by foreign railways at a *per diem* rate, instead of at a mileage rate *without demurrage*, for wagons going on to their lines, and already an improvement is noticeable in the work obtained from wagons. But so long as the first two factors are in operation it is impossible to form any judgment from annual returns of the use American railways make of their rolling stock.

POOLING OF ENGINES.

188. To avoid engines lying idle needlessly, they are pooled, that is, they are not confined to one crew of enginemen and firemen. The practice is followed with both Passenger and Goods engines, but the procedure differs with the two classes, and is as follows: Pooling of Engines.

With passenger engines there is a limited pool, that is, there are two or three sets of men only assigned to each engine, one taking it to the out station and another bringing it back, or one crew doing the first return trip, and the second crew doing the next, and so on. Under this arrangement, more work is got out of an engine than would be possible if it was confined to one crew, but not so much as it might do. In times of pressure the number of crews is increased and the engine kept running continuously, time only being allowed for it to turn round and be made ready for the next trip. Practice with passenger engines.

The engines of fast goods trains are pooled in the same way as Passenger engines. Fast goods engines.

The engines of local goods trains, that is, trains by which wagons and packages to and from wayside stations are dealt with are not pooled; but special men are employed for this service who are paid higher wages, so as to familiarise them with the work and the wants of the stations. Engines of transhipment trains.

For the engines of all other Goods trains there is an unlimited pool, and engines go out as fast as they can be turned round. Crews are maintained at both ends of an engine run, to ensure the crews getting the proper amount of rest, and the men go out in the order of first in first out. Goods engines.

189. Once a week fires are dropped for stay-bolt examination, and the boiler may be (though this is not necessarily done) washed out at the same time. Once a week, or once a fortnight, or once a month, according to the quality of the water in the district, the boiler is washed out. Engines periodically examined.

190. Immediately the stay-bolt examination or the washing out of the boiler is finished, the engine is lighted up. This takes 40 minutes only, though it can, under pressure, be done in 20 minutes by forced draught. The method followed is to sprinkle crude oil over the coal in the fire-box and to attach an independent blower to the front end to make a draught. The engine then leaves the Round House, and is sanded, watered and coaled, the cleaning of the ash-pans being done at the same time. The coal is supplied through shutes, and not by manual labour. Manual labour never is employed where machinery can do the work, not only because of the economy in money, but because of the much more important economy in time. In this way an engine can be got ready for service in less than an hour after she has been released from examination, and is often got ready in half that time. Time taken in lighting up engines, from half an hour to an hour.

191. The following figures will show the average time *per diem* all the engines in service were, under the Pooling system, in the Round House, that is, out of the service of the Operating Department, both at head quarters and at out stations, during one week, in five several districts of one railway:— Average time engines out of use under system of pooling.

District.	Number of Round Houses at which Engines turned.	Number of Engines working.	Average Time between Ash-pit and Turn-table.	In Round House for Repairs, &c. Average Time.	Total Average Time out of service of Operating Department *per diem*.	Average Time held for Trains after ready for service.	Total Average Time Engines were ineffective *per diem*.
			Hours.	Hours.	Hours.	Hours.	Hours.
A	5	397	1·02	2·39	3·41	3·00	6·41
B	3	236	·52	2·38	3·30	1·16	4·46
C	5	324	1·00	3·18	4·18	3·14	7·32
D	5	192	·58	1·40	2·39	2·53	4·92
E	3	108	1·17	1·27	2·44	1·25	3·65

Pooling of Engines.

Paras. 192—197.

Engines confined within Master Mechanic's district.

192. In pooling, as a general rule, engines are kept within the Master Mechanic's District, as by so doing it is possible to exercise some check on the repair account, and to fix responsibility on the Master Mechanic for any neglect of duty by the men under him. In times of great pressure, however, engines are allowed to go on to another District, but this practice is discouraged, as it becomes impossible then to fix responsibility for abuse of the engine.

Inspector examines engine as it comes in.

193. In every Round House or engine shed, there is an Inspector, to whom the Engineman reports the condition of the engine before going off duty. The Inspector examines the engine, and reports to the Foreman in charge of the Round House (there is one in every Round House) what work has to be done on the engine as reported by the Engineman and as found by himself. If the Inspector considers the engine has been abused, he reports the Engineman to the Master Mechanic, who reports him to the District Superintendent for discipline.

To encourage emulation, the performance of each trip is posted up daily on a bulletin board in the Foreman's Office, and the men are able to see how each man is doing.

While running, abuse of engine checked by Road Foreman of Engines.

194. For the control of the Enginemen while on the road in mechanical matters (in all matters of operation they are under the Train Master) a Road Foreman of Engines, with as many assistants for the different engine runs as may be necessary, is employed, who is entirely independent of the Master Mechanic, and is a sort of Locomotive Inspector of the District Superintendent. He exercises supervision over the engines and crews while they are away from the Round House, and is responsible for seeing that the engines are properly and economically operated.

195. That the engines are not seriously abused is clear from the number under repairs. In 1902, on one large system, the average was not 8 per cent. of the total locomotive equipment, but this was regarded as high and was put down to the excessive work taken out of the engines during a period of unusual demand. The normal figure is about 6 per cent. only.

Pooling does lead to extra expense on repairs, but this compensated for by savings.

196. It was, however, nowhere contended that the engine did not receive better treatment when confined to one crew than when pooled; but the enormous saving which resulted from pooling, both in first cost of engines and in standing room in Round Houses and in shops, was considered to more than compensate for the increased repair account, and was held to fully justify the practice.

Effective supervision secured by system adopted.

197. The essential condition for the successful operation of the arrangement is careful supervision.

By confining the engine's runs within the District Superintendent's District, and by the system of check exercised through the Inspector in the Round House and the Road Foreman of engines on the road, it is possible to make the supervision thoroughly effective.

All judged by Results.

Results are the test of all work in America, and if the engines are being abused or neglected, this is very soon reflected in the statistics of operation, and responsibility can immediately be placed on the right shoulders. All Results are made as public as possible, and as Results are the standard for advancement, neglect of duty is kept within reasonable bounds, and the tendency is both for enginemen and the supervising officers to strive to do better than their neighbours, that is, to show better Results.

Emulation is the great safeguard, and that is encouraged in every possible way.

CHAPTER VI.

PASSENGER TRAFFIC.

PASSENGER FARES.

Classes of Passengers in America.

198. American railways claim that they have only one class of passengers, but as a matter of fact there are two, namely, those who travel in the ordinary carriages provided by the railway, and those who travel in the Pulman parlour and sleeping cars. The claim is due to the fact that the *railway* only charges the same fare to every passenger, no matter in which class he travels, and the extra payment for the use of the Pulman car is paid direct to the Pulman Company or their representative.

As the railway realises only the ordinary fares, all American statistics show only these charges and ignore those made by the Pulman Company. As a consequence, the fare shown as paid by passengers in America does not correctly represent the amount actually paid for a journey, and is misleading.

Fares Average 1·98c. per passenger per mile.

Pulman charges average ½c. per mile.

Average fares in America.

199. The fares charged by the railway vary considerably. The normal fare is 3 cents, or 18 pies per mile, but the fare actually charged in 1902 works out for all American railways to an average of 1·98 cents, or 11·88 pies, per passenger per mile.

No statistics of the charges made for the use of the Pulman car are published, nor are the rates based on distance. They are arbitrarily fixed, and average about ½ cent, or 3 pies, per passenger per mile.

The average fares, therefore, charged in America in 1902 were:—

	Cents.	Pies.
For Pulman car per passenger per mile -	2·48	14·88
For ordinary car „ „ „ -	1·98	11·88

Average fares in India.

The average fares charged in India in 1902 were:—

	Pies.
First class per passenger per mile - - -	12·86
Third class „ „ „ - - -	2·33

Fares in India lower than in America.

It will be seen, therefore, that the fares actually charged for both these classes are very much lower in India than in America.

Conditions in two countries compared.

200. In making this comparison, however, it is necessary to consider the conditions obtaining in the two countries before any conclusion is possible as to whether the rates in India are such as the "traffic will bear."

The rate of wage in America for unskilled labourers averages $1·25 or 750 pies, or Rs. 3. 14. 6 a day. By the expenditure of one day's wages such a man can travel over 63 miles. By the expenditure of a month's (30 days') wages he could travel 1,894 miles.

The rate of wage (not average) in most parts of India for the same class of worker is 2 annas or 24 pies a day. By the expenditure of one day's wages such a man could not travel more than 10 miles, and his whole month's wages would only carry him 300 miles.

Fares in America relatively lower.

While, therefore, the fares charged to the lowest class of passengers are *actually* lower in America than in India, *in effect* they are much higher. As a consequence, the travel is much more restricted in India than in America, as may be seen from the following figures:—

Country.	Year.*	Population.	Passengers Travelling.		Travel per cent. of Population.		Population per mile of Railway open.
			Number.	Total Distance travelled.	Number.	Mileage travelled.	
America - -	1900	75,994,575	576,865,230	16,039,007,217	855	21,105	393
India - -	1901	294,361,056	194,749,000	7,871,754,580	66	2,667	1,162

* Figures are given for the last census year in the two countries.

Currency of ticket unlimited.

201. No limit is placed on the curreney of a ticket. A passenger is not obliged to begin his journey on the day he purehases his ticket or by any particular train, nor is he obliged to *complete* his journey in the train in whieh he *began* it. He is, further, not obliged to make the journey in the exact direction indieated on his ticket, that is to say, a ticket issued from A to B, if unused, is good for a journey from B to A.

The view taken is that the ticket is merely a reeeipt acknowledging a eertain sum in payment for one of the commodities in which the railway deals, namely, passenger transportation between two points; and it has been held that until the railway fulfils its part of the transaction, that is, until it provides the transportation between the points for which payment has been made, the tieket remains valid, and the railway has no right to fetter in any way the freedom of the other party to the transaction, namely, the passenger.

In issuing season or "commutation" tickets one tieket to cover the whole period is not issued, but separate tickets are issued for the number of trips the passenger is permitted to make. This prevents all possibility of fraud where there is no eollusion.

Forms of tickets.

The number of forms of tickets used in Americe is legion. (I have specimens of all the tickets in use, and they will be available for reference at any time they are required.) They were all designed to serve a special purpose, and effeetively do so. Arrangements for the printing and supply of tickets are made by the Traffic Department, and the Auditor only furnishes the forms in whieh their issue is reported.

PASSENGER SERVICE.

Service also better.

202. The train service is very mueh more frequent in America than it is in India. Comparison in this respect is always difficult. Basing it on the population of towns the service eompares as follows:—

——	Population.	Distance apart.	Number of Trains each way.
America:—			
Boston -	560,892	108	17
Portland -	50,145		
India:—			
Bombay -	776,006	119	7
Poona -	153,320		

The population of Bombay is greater than that of Boston, and of Poona three times as great as that of Portland. The American cities are served by 17 trains a day each way, while the Indian cities only have seven each way. The trains in America are also very much faster, and the class of serviee rendered to the lowest class passenger, is in every respect superior.

I have selected Bombay and Poona for eomparison, beeause the distances more nearly agree, and because there is a better service here than in any other part of India; and because the rate of wage for the labouring classes in this part of the country is higher than anywhere else.

Development possible by reducing fares, &c.

203. While wages are as low as they are, it would be hopeless to expect the same amount of travel in India as takes place in Ameriea. An inerease in the rate of wages can only come with the development of the natural resources and wealth of the eountry; and before traffic can be developed to any great extent, the fares require to be brought more within the reach of the multitude.

204. Such conveniences as have been provided in America for passengers were only to a very limited extent forced on the railways there, but were provided by the railways themselves with a view to encouraging traffic, even though at first and for some time they may have involved the railway in loss. Many a city in America has been built up in this way by the enterprise of the General Passenger Agents, and the frequency of the train service notwithstanding, the passenger traffic is not the least profitable part of the business of American railways. Conveniences given to develop business.

Passenger agents do not devote their attention only to local business, but are always striving by the most attractive advertisements and descriptions of places, not only in America but outside that country, and generally by bringing to the notice of the public where there are openings for men seeking employment, to build up traffic; and do not hesitate to reduce fares where they stand in the way of the development of business. The extent to which this is done may be judged by the fact that the best map of China which could be found in America during the recent complications, was the one issued as an advertisement by Mr. Daniells, the General Passenger Agent of the New York Central and Hudson River Railroad. Passenger Agents constantly on move to get business.

With the same object in view, endeavours are made to encourage people to settle as far away from cities as possible by low rates for season tickets and good trains to come in and out by. This gives the railway a permanent population along the line, and not only increases their passenger business, but also gives them a not inappreciable amount of goods traffic. People encouraged to live in suburbs.

205. In the effort to develop business the speed of passenger trains has gone on increasing. As the business developed, the weight of the train has also increased; and all over America I found heavy trains, trains equal to 20 and 22 four-wheeled coaches, being hauled at high scheduled speeds, even when the road was not particularly level. One journey I made was rather remarkable in the matter of speeds. It was from Philadelphia to Atlantic City and back. The train, which was one of the regular daily trains, had a load of seven coaches (equal to 14 four-wheelers, possibly more than 14) and 171 passengers, and weighed 224 tons behind the tender. The distance between the two places is 58·3 miles, and the time allowed for the journey was 54 minutes, or an average speed of 64·8 miles an hour. We ran to time and for 22·5 miles ran at a speed of 84·3 miles an hour. Speed of trains high, and weight of them heavy. Philadelphia to Atlantic City.

This same train on another occasion had a load of 13 coaches (equal to 26 four-wheelers) and weighed 422 tons behind the tender. It nevertheless accomplished the journey without difficulty, and, but for a delay of three minutes caused by another train, would have reached its journey's end to time. The road is a double track laid with 100 lbs. rails, 60 ft. in length, and is fairly level and has very few curves. These speeds maintained with heavy loads

The service between Philadelphia and Atlantic City was introduced to encourage business, and has more than justified the enterprise of the Pennsylvania Railroad Company. There was no traffic on the line to speak of, but by a frequent and fast service of trains, reductions in rates, and careful advertising, a very remunerative business has been built up. This service introduced to develope traffic.

On the New York Central Railroad there is a train of 16 bogie coaches (equal to 32 four-wheelers) which runs from New York to Albany daily. Its gross weight behind the tender is 795 tons, and it accomplishes the journey of 143 miles in 3 hours and 15 minutes, or at an average speed of 44 miles an hour. Results on New York Central Railroad.

206. To secure these results, the engine for the Passenger service is being constantly improved. In America they never wait for a thing to wear out completely before they make a change; and the object sought is to get an engine which will not only travel at a higher speed, but one which will also take a heavier load at the same time. Engines being improved.

PASSENGER CARS.

Passenger vehicles all of bogie type.

207. Every Passenger vehicle is on bogies, the ordinary cars on two trucks with two pairs of wheels each, and the Pulman on two trucks with three pairs of wheels each.

Advantages of end-opening cars.

Every car is end-opening and it is possible to walk from one end of the train to the other. The advantage of this is that a passenger has not got to rush round the train to find room. He gets into the first carriage and finds a place at his leisure, and the overcrowding of some carriages, while others are comparatively empty, is avoided.

End-opening cars unsuitable for suburban traffic.

208. While, however, the advantages of the end opening car for the free circulation of passengers are indisputable, it has been found in the suburban business, that with only one entrance and one exit to each car, much delay occurs in emptying or filling a car if the number of passengers is at all large.

Difficulty overcome by carriage with both end and side doors.

To overcome this difficulty, Mr. A. W. Sullivan, President of the American Railway Association and Assistant Second Vice-President of the Illinois Central Railroad, has designed a carriage * which has side doors, as well as passages down both sides of the train. The doors slide instead of working on hinges, and are simultaneously closed by a lever at the end of the car. As a station is reached, the doors are released and the passengers open them themselves, the object being to avoid opening doors unnecessarily. Before the train starts, the guard closes all the doors at one operation. Only two trains of these carriages have been built so far, but others are under construction.

I made several trips in one of these carriages, and it seemed to me to solve the difficulty of the suburban traffic. The doors move freely and slowly, so that there is no danger of crushing passengers; the seats are arranged along the centre of the car, face to face and back to back. Each seat accomodates four passengers and there is a door for the two seats facing each other. The carriage holds 100 passengers, and there is standing room without overcrowding or discomfort to the other passengers for another 50 passengers. To get the *two* side passages in, the carriage has had to be built 10 ft. 6 ins. wide, or six inches wider than an ordinary carriage; but no difficulty was experienced in doing this. I may add that the car weighs 37·8 tons.

Carriages have no sunshades.

209. In India, all carriages are built with sunshades. In America they are built without them, although in the Southern and some of the Central States the temperature in many places is nearly, if not quite, as high as it is in most parts of India; and all that is done for the protection of the passenger from the sun's rays is the provision of a thick cloth blind.

American cars badly ventilated. Pennsylvania RR., designed car to overcome difficulty. Carriage might overcome heat difficulty.

210. American carriages, especially the Pulman cars, are not well ventilated, when all the windows are down, as they generally are to keep out the dust and smuts from the engine. To keep the air circulating, the Pennsylvania Railroad have designed a car which admits fresh air at one end of the roof through a channel to the floor of the carriage, carrying off the foul air through openings along the roof. It struck me that by the arrangement of a khus khus tattie, automatically fed with water, or by placing a block of ice at the opening where the air enters, it might be possible to pass cool air into the carriage, and, while purifying the carriage, also cool it. I mentioned my idea to the Superintendent of Motive Power who built the carriage referred to, and he seemed to consider it would be quite possible.

The great difficulty in Indian railways is to get carriages cool during the hot months. The first and second class carriages are provided with khus

* A full description of this carriage will be found in the "Railway and Engineering Review" of 5th September 1903, "American Engineer and Railroad Journal" for June and October 1903, and in the "Railway Age" of 4th September 1903.

khus tatties, but they are not of great practical use. The lower classes have nothing, and they have the largest number of passengers in them. I have plans of the Pennsylvania Railroad carriage, and in the adoption of it may be found a cheap solution of the difficulty in regard to the cooling of carriages.

Communication cord.

211. Every train in America is fitted with a communication cord, which runs along the centre of the train, suspended from the roof, and within reach of passengers. When pulled, it blows the engine whistle by opening a valve at the end of the car, which is connected by an air pipe with the engine.

Accommodation good for lower class, but better in India for upper classes.

212. As to the kind of accommodation provided on trains in America, that for the ordinary traveller is good. The cars are arranged with a passage down the centre, and benches to hold two on either side, all facing towards the engine. They are comfortable, and by the arrangement of the seats, overcrowding is prevented. The accommodation provided for the upper class passenger is the Pulman parlour and sleeping car. It is good; but for comfort and reasonable privacy, especially on night journeys, I think the accommodation given to first and second class passengers in India is better. But the conveniences provided for such passengers on the best trains, in the shape of sitting and writing rooms, stenographers, typists, barbers, and ladies' maids, has no counterpart in India.

Dining cars.

213. To almost every through train there is attached a dining car, where an excellent meal can always be obtained at a not unreasonable rate. Where there is no dining car, light refreshments can always be obtained from the porter of the Pulman car. For the passengers on the ordinary cars, fruit and candies are purchasable from the man on the car who supplies newspapers and books. Every train has such a man on board. In addition, at every station of any importance, refreshment rooms are provided, where hot or cold meals can always be obtained without notice.

Newspapers and books obtainable.

TIME TABLES.

Changes in timings of trains, how arranged.

214. When a change in the timing of trains has to be made which affects more than one road, a meeting is called of the Trunk Line Association, which arranges the details. The meeting is usually held from a month to six weeks before the change has to come into force.

When a change has been decided upon, if it affects more than one Division of a railway, the General Manager or the General Superintendent of Transportation calls a meeting of the General Superintendents, and they decide at what hours through trains are to arrive at and leave Division termini. The General Superintendents then call a meeting of their Passenger Train Masters, or District Superintendents, or both, according to the importance of the changes, who decide at what time the through trains are to arrive at and leave the District termini. As soon as these details are fixed, each Passenger Train Master prepares the timings for intermediate points and for the branch, local and suburban services on his District, and sends the changes to the Press, which is located at the headquarters of the General Superintendent, but does not usually belong to the railway. If the changes are not numerous (the forms are always kept standing) a proof can be obtained in a very short time, but in no case, I was told, did it take longer than six hours. The proofs are checked by the Passenger Train Master, and the bills are then issued over the signature of the District Superintendent, each District separately, with the timings at all stations on the District shown. A summary is also prepared showing the timings at the principal stations on the Division.

Time tables show in detail Stations on District only.

The time tables are then turned over to the Passenger Traffic Manager, or General Passenger Agent, who prepares and issues the leaflets for the use of the public in such form as he thinks will be most attractive.

Traffic Department prepare bills for public.

Sheet tables cover district only.

Sheet time tables for exhibition at stations are also prepared by the District Superintendent, but they only give timings in detail for the stations on the District. Where there is room, the whole District is shown on one sheet; where there is not, one sheet is prepared for main line stations and one for branches.

Numbering of trains.

215. In numbering Passenger Trains, numbers from 1 to 100 are usually reserved for main line trains. The trains on the first branch have 100 added, that is, their numbers begin with 101, on the second branch 200 are added, and so on. It is thus possible for the number to readily tell on which section of the line the train runs.

PASSENGER STATIONS.

Station buildings replete with all modern conveniences. Rooms well-arranged.

216. The modern passenger stations in Ameriea are replete with every kind of comfort, the Boston Terminal Station, which is the latest building of the kind put up, even going to the length of providing free of all charge a small hospital and fully equipped cribs for babies in the women's waiting rooms the linen in which is changed every time the cribs are used. All the different rooms are well arranged, and the one idea uppermost in the mind of the architect has been to provide ample space and to arrange the accommodation to afford the greatest amount of comfort to the traveller. To secure this, the ticket offices open not only on to the platform but on to the waiting halls, and these again lead directly into the refreshment rooms. The rooms are well ventilated and lighted, and in cold weather well warmed with steam heat. There are post, telegraph and telephone offices provided in all the modern station buildings off the waiting halls, as also lavatory conveniences of the most up-to-date kind. At Boston Terminal, the Company manufacture their own ice, and iced water is laid on to every room in the building, and can be drawn off at any of the taps distributed over the platform. It may also be mentioned here that every car on every train is provided with a filter from which *iced* water can be obtained by passengers at any time.

Iced water provided.

Platforms for trains separate from general platform.

217. At terminal stations between the waiting halls and the train platforms is a wide platform to allow of the free circulation of passengers. Passengers can only obtain access to the train platforms through gates which are opened a short time before the train is due to start. Each of these gates connects with one platform, and on each side of them there is a notice board on which is shown the names of the stations at which the train starting from either side of the platform will stop, and the hour of its departure. Passengers have consequently rarely to ask questions as to their trains. At Boston Terminal this board is most ingeniously contrived. It is, of course, a patent, the inventor or rather the manufacturer of the Train Indicator being Wheeler and Wilson, Bridgeport, Conn.

Platform usually at rail level. Advantages of this.

The platform is almost always at rail level, and with the end-opening car, which is in common use in America, no inconvenience is experienced from this. At other than terminal stations these platforms facilitate the movement of passengers from one platform to another, and save them the labour of climbing across over bridges, and at all stations they facilitate the distribution of luggage between the several trains. Such platforms would be impracticable with side-doors, and the raised platform, when it does exist, as in some of the suburban services, would be unsuitable for the end-opening car but for the fact that a short platform is provided at the end of the car to cover the steps ordinarily used.

LUGGAGE.

Luggage, handling of, leaves everything to be desired.

218. While the method of dealing with luggage in America is practical and good, the manner of handling it leaves everything to be desired. It is extraordinary how American railways, who do give so much attention to every little detail affecting the comfort of their patrons, have done so little

to protect their baggage. Nothing but an iron box could stand the rough handling all luggage is subjected to. Labour is of course scarce and expensive in America, but this is not a question of scarcity of labour, but most inexplicable indifference on the part of all, authorities and porters alike, to the claims of their patrons on their consideration. The way luggage is treated in America is a standing reproach to their otherwise excellent and considerate management.

American system of dealing with luggage.

219. In dealing with luggage the American system is peculiar to that country. No article is received for conveyance as luggage which is not fitted with handles.

Tags or strap-checks used; system described.

The labels are in the form of "tags" or "strap checks," which are printed in duplicate, both portions bearing the same number. On presentation of luggage to be booked each package is given one of these labels, all differently numbered of course. The upper half of the label is tied on to the handle of the package and the lower half is torn off and given to the passenger, and until this check is presented and matched up with the other half, delivery is refused. This is the only receipt given by the railway, and both portions of the tag are taken up when delivery is given. Where the bookings from a station are very large, the "station from" is printed in, but otherwise rubber stamps are provided for the "station from" and for the principal "stations to." Where the bookings are infrequent and there are no rubber stamps for the station, the name is entered up in ink. In the margin is given a full size diagram of the tag used, which will perhaps make the method followed clearer.

BOSTON & ALBANY R. R.
(N.Y.C. & H.R.R.R. Co., Lessee.)
SPECIAL STRAP CHECK.
From BOSTON
To DENVER, COL.
Viâ B. & A.
N. Y. C. — M. C.
Burlington Route.
No. W 180
This check is to be used for foreign baggage only. Receiving Agent will not under any circumstances re-issue this check.

BOSTON & ALBANY R. R.
(N.Y.C. & H.R.R.R. Co., Lessee.)
SPECIAL DUPLICATE CHECK
From BOSTON
To DENVER, COL.
Viâ B & A.
N. Y. C. — M. C.
Burlington Route.
No. W 180
BOTH STRAP AND DUPLICATE CHECK MUST BE FILLED IN WITH INK.

Luggage not weighed unless apparently excessive.

220. No luggage is booked unless the owner presents his ticket to show he is a *bonâ fide* passenger. If the number of packages is not excessive, the luggage is not weighed. But if the quantity appears to exceed the free allowance of 150 lbs. it is weighed and the excess charged for, and a separate receipt given for the amount. In the carriages there is practically room for only a small hand-bag or two, and no more than this can be taken in without incommoding oneself, to say nothing of the other passengers. The discomfort of this on a long journey is great. Passengers, however, may have access to their baggage in the baggage car by presenting their "checks"; but this is only a mitigation of the inconvenience, not a removal of it.

Room in cars only for a small hand-bag or two.

Express Companies carry baggage from station to homes of passengers.

221. The luggage is never delivered until it has been brought from the train into the inwards baggage-room, and the delay in its getting there often deters passengers from going to take delivery of their luggage themselves. At most stations there is an Express Company, who have an agent at the station and on the more important trains, who arranges to deliver all luggage at peoples' residences, and most people find it more convenient to use this agency for the transportation of their baggage to their homes. All that the passenger requires to do is to make over the duplicate checks he received

to the Company's representative; and it is here that the advantage of the check system is so much felt, and its value, where the owner cannot himself go and identify his baggage, must always be great both from the point of view of the railway and that of the passenger. It is in every way simple, and the only objection to it is that the passenger has to carry about the duplicate checks, which would be inconvenient if the number of packages was large.

Baggage Master receives no way-bill but prepares his own record.

222. On every train there is a man who travels in charge of the baggage called the Baggage Master. Where the quantity is usually small, the Brakesman performs the duty; but where it is large a special Baggage Master is employed. A check is kept in the outwards baggage-room of the number of each "strap check" issued and the station of destination, and the luggage is sorted for the train by which it is to go, but no covering way-bill or document is given with the packages to the Baggage Master. He is required to prepare his own record and to give a list of the packages he delivers up at each station with them.

Supply of wheel-barrows plentiful.

223. There is a very plentiful supply of hand barrows and luggage trucks, so designed as to make the shoving of them as easy as possible, and the amount of time these save is great. In India we are rather apt to be niggardly with our supply of barrows, and do not give sufficient attention to lightness of draft.

Method of storing luggage explained.

224. In the inwards baggage-room the space is divided up, each being numbered from 1 upwards. When the luggage is brought here, it is placed in these spaces according to the first figure in the strap-check number. Thus, a package numbered 317959 would be placed in bay No. 3.

When delivery is given a record is kept of the number, station from, and person to whom delivered if he is not the owner himself.

System suitable for American conditions, but its suitability elsewhere doubtful.

225. The whole system is expeditious, and the losses through negligence and fraud were, I was assured, not worth consideration. It suits American conditions splendidly, but whether it would be practicable in countries where porters are plentiful and passengers have become accustomed to going to the luggage van and removing their luggage as soon as the train arrives, and where no arrangements exist for the delivery of the luggage at the homes of passengers, I am a little doubtful.

PARCELS.

Parcels work done by Express Companies.

226. There are very few railways in America which carry Parcels. The whole of this work is done by Express Companies, who accept from the public any class of matter which is offered to them, picking it up at their homes or places of business and delivering it at the doors of the consignee. They carry the package in their own carts to their depôt at the station, where it is weighed and way-billed. The packages, when the size permits, are then packed into boxes, and loaded in baggage cars which travel in charge of their own men, who deliver at the station of destination to the representative of the company, who arranages for delivery to the consignee.

Railway provide cars and receive percentage of Express Company's takings.

227. The railway company only provide the baggage cars and haul them, and for this service the Express Company pay them an agreed upon percentage, which varies from 20 to 50 per cent. of the charge made to the public. The percentage varies according to the nature of the traffic. Where the country is densely populated and the haul is short, the percentage is low: where the haul is long, the percentage is high.

228. These Express Companies carry bank notes, gold, silver, and valuables of all kinds; they make collections of notes, drafts, &c., and they recover any charges specified before delivery.

Express Companies carry any and every kind of traffic.

The railways use them for the collection of their station earnings; and there is no business that they do not undertake which is in anyway connected with the movement of passengers.

229. The charges to the public for the service vary according to distance, and run, for 100 lbs. shipments, from 25 c. (2 c. = 1*d.*=12 pies) per 100 lbs. for short hauls, to $8 or $10 ($1 = 4*s.* = Rs. 3) for long distances.

Charges made for service.

Shipments of less weight are charged a higher rate per pound, and the charge varies according to the weight and class of matter offered, all commodities being classified in much the same kind of way as goods are.

The charges made by these Express Companies are high, but they are generally regarded as a great convenience, both by the public and by the railways.

Charges high, but convenience great.

CHAPTER VII.

RUNNING POWERS AND INDEPENDENT JUNCTIONS.

RUNNING POWERS.

Running powers usually obtained without difficulty.

230. In America vested interests are never allowed to interfere with the public interests, and no difficulty is placed by the Government in the way of any railway extending its line into any town or city it wishes to reach. There is, consequently, never any trouble in one railway obtaining running powers over another. It is always recognised that if the request is refused, the railway seeking running powers will build its own line, and it is generally found economical to get some one to share the cost of maintaining and operating a section of line or a junction.

Charges to user company varies.

231. The charge for the exercise of running powers varies under every agreement. On one railway whose agreement I have before me, the charge is—

> "At the rate of 2 mills (1·2 pies) per ton of 2,000 lbs. per mile for all freight and express matter; 1 cent (6 pies) per mile for each through revenue passenger; and 1½ cents (9 pies) per mile for each local revenue passenger; carried by the party of the second part over the said railroad of the party of the first part."

And it is agreed between the two parties that—

> "The trains of the party of the second part are to be run, operated and controlled according to the time tables, rules and regulations of the party of the first part, which are to be established after consultation with the proper office of the party of the second part and conformed to the needs of the party of the second part as far as practicable. . . . . Each of the parties hereto shall be liable to the other for the exercise of that care and vigilance which is exercised upon well managed railroads, and in case of any accident, loss or damage which either party may sustain, incur or become liable for by reason of the default of the other, the respective rights and liabilities of the parties hereto shall be determined in accordance with the aforesaid rule and not otherwise. . . . . Neither party shall compete with the other for business going to or from points upon the railroads of the other. Rates shall be agreed upon by the general freight agents of the parties hereto, for all points reached by both parties directly or by means of intervening lines; such rates not to be higher than the rates made by any other competitors to such points. . . . . Freight brought by the party of the second part to be delivered on the railroad of the first part shall be delivered by it to the party of the first part at the first point of intersection, and the party of the first part shall take the same to its destination at local rates unless otherwise agreed upon.
>
> "Nothing herein shall be construed to allow the party of the second part to do any local freight business on the line of the party of the first part between its points of intersection above referred to, points of intersection inclusive, or to or from intermediate points, except as covered by a joint tariff to and from such intermediate points."

Conditions imposed.

Trains allowed, to meet demands of user.

Each line to be responsible to the other for due care in operation.

Competition for local business prohibited

Freight for owning line to be delivered at first point of intersection.

Carriage of local business prohibited.

CHAPTER VIII.

WORKING OF TRAINS.

TRAIN DESPATCHER SYSTEM.

Train Despatcher.

236. At the root of every system of train movement in America is the Train Despatcher. It is an office not easily intelligible to railway officers in other countries, and the duties and functions of the Train Despatcher may be better understood by describing his evolution.

237. In the early days of American railways, when cheapness of construction and operation were the first considerations, telegraphs were regarded as luxuries and few railways were equipped with them. Labour also was scarce and expensive. The traffic was not heavy, but trains moved in both directions, and some system had to be devised for passing these with some degree of safety.

Method of working adopted before days of telegraph.

The first step, therefore, taken was to provide passing sidings at intervals. These were not protected by signals, nor was any one placed in charge of them. The guards of trains were supplied with keys to the points, and opened them when they required to go into or leave the sidings. Midway between two such passing sidings a post was put up. A time table was prepared for the trains, and the crossing places fixed, but if on arrival at a meeting point the train from the opposite direction had not arrived, the train which had arrived went on. If it met the opposite train on the near side of the post, it backed. If it got past the post, the other train backed until it reached a passing siding.

Superintendent.

In charge of the train service was a Superintendent, and his business was to travel up and down his district all the time, and to instruct the men as to the order in which trains were to be worked.

System followed when telegraphs were introduced.

238. Later on, the telegraph was introduced, but it was found too expensive to equip every passing siding with a telegraph office. The Superintendent, therefore, as before, had to regulate the movement of trains, but instead of travelling up and down the line all the time, he was now able to issue his orders from his office through the telegraph operator at the different telegraph stations.

Trains worked on time table.

A time table was prepared as before, fixing the crossings and the times of arrival at and departure from the several stations. Any train which was running to time could go straight ahead; but if it was late, even by a few minutes, it lost its "right of way," and had to keep clear of all trains in the opposing direction, until it could get to a telegraph office. The Superintendent, or as he now came to be called, the Train Despatcher, was then referred to, and orders were issued to all trains concerned, altering the crossings given in the time table, and fixing the points at which crossings were now to be made.

When trains late, Train Despatcher referred to for orders as to crossings.

Under later development, Train Despatcher gave orders without being referred to.

239. Later on again, the practice grew of reporting to the Train Despatcher the movement of every train past each telegraph office. He then was able to see for himself when trains were thrown out of their course, and without reference from the train staff, he issued orders altering the meeting points. Where the trains were running to time no orders were issued. Where they were late, the orders were sent to the train staff concerned, and the telegraph operator at the stations to which the message was addressed exhibited a signal to warn passing trains that he had orders for them, and they were obliged to stop and receive and sign for such train orders.

Passing sidings not protected by signals. Guard had keys of points.

The passing sidings continued to have no one in charge of them and were provided with no signals. The points were locked over for the straight line, and the guards had themselves to open them to enter and leave the sidings and were responsible for locking them again after they had done so and when they left the siding.

Even at stations where there were telegraph operators, no signals were provided except the one which was exhibited when train orders had to be issued, nor was the operator provided with keys to the points.

Trains expected to work to time table. If late, had to keep clear of opposing trains.

240. All trains were worked strictly to Time Table, and every train was expected to arrive at its meeting point and be clear in the siding before the opposing train was due. If for any reason a train could not make the crossing at the place fixed, it was required to side track at some passing place in sufficient time to prevent delay to the opposite train, or, if this was impracticable, the guard had to take steps to protect his train until he could reach a telegraph office and obtain orders from the Train Despatcher.

Mileage operated under system.

241. At the end of 1902 there were 202,472 miles of railway in the United States of America, of which, 13,721 were two-track, 1,204 three-track and 895 miles of four-track lines. The Train Despatcher system is in force on every one of these.

On the single-track lines, subject to rare exceptions where some form of automatic block signalling is installed, the system followed is, with modifications, that described above. On lines with two or more tracks, where no automatic block signalling has been introduced, the same system with modifications applies. In both cases passing sidings exist where there are neither telegraph offices nor signals, and at places where there are telegraph offices, even on well regulated roads, often the only signal provided is that which is exhibited when train orders have to be given to the train staff.

On lines where there is a system of automatic block signalling in operation, the movement of trains is regulated by the block signals, but the Train Despatcher still keeps track of them, and issues orders for any movements requiring a departure from the time table.

Train following permitted, with goods trains.

Except on lines worked by the automatic system of train signalling, goods trains are allowed to follow one another, without any specified interval of time, and I saw no less than three goods trains on one section at one time.

Passenger trains are not allowed to follow or be followed.

Train Despatchers —number employed.

242. Four Despatchers are employed in every office, three men being on duty eight hours each and the fourth being kept for purposes of relief. Each man goes on for twelve days without change, and then has two days off, one of which he is required to spend on his district to learn its physical conditions, and note changes made since his last visit. Each Despatcher has an assistant Telegraph operator who does all his writing work, and is in training for Despatcher.

Train Despatchers fix how much time a late train may make up.

243. The Train Despatchers are rarely transferred, and in time get to know, from the daily performance of the engine and guard, what time a late passenger train can make up. They then notify the train what time it is authorised to make up on the journey (a limit which may not be exceeded), fix the crossings or passing points for passenger trains, and notify all goods trains which may be affected, how much late they are to allow for the train running, so that they may not delay the passenger train or be needlessly delayed waiting for it. In America the guards of goods trains are held entirely responsible for keeping clear of all passenger trains, and trains of superior class, and no attempt is, as a rule, made by the Train Despatcher to regulate the movement of goods trains.

As business grew, Train Despatchers found it difficult to cope with it.

244. As, however, the business grew, difficulty was experienced by the Train Despatcher in handling the traffic. On the more advanced lines it was recognised that the strain on the human agency was becoming greater than it could bear without mechanical help, and some system of automatic train signalling is being introduced to supplement the Train Despatcher. On other railways, while the advantages of improved methods of signalling are admitted, the railways have not so far been able to afford automatic signalling, and an effort has been made to meet the difficulty by reducing the length of the Train Despatcher's charge when the density of the traffic required this; and the charge of a Train Despatcher in busy districts may now cover as short a distance as 30 miles. He is connected by one wire, on the close circuit, with every telegraph office in his charge, and every message received is repeated back to ensure accuracy.

Charge of a Train Despatcher.

In judging system, American conditions must be remembered.

245. In judging the system under which trains are moved in America, the peculiar circumstances of the country require always to be borne in mind. When railways were first constructed labour was not plentiful and was expensive when procurable. Even when existing towns were connected, the traffic was not expected to be heavy enough to justify a high standard of construction, nor was it financially possible to adopt the most approved methods of operation. In the case of a large majority of the railways, they had not even existing towns to rely upon for business. They were taken into absolutely virgin country; they were, in fact, the pioneers, and the population and towns followed. Without the railway, the country would not have been opened up; and when the railway was provided, it had necessarily to be built and operated at a minimum of cost. If a high standard of construction and operation had been demanded, in most cases the railway could not have been built at all.

Risks had to be taken, and if a few suffered occasionally, by far a great many more benefited. The greatest good to the greatest number had to be the governing principle.

Risks taken.

Present prosperity tending to improved methods.

246. It is only during the last very few years that the majority of the American railways have emerged from a condition of insolvency, and advantage is being taken of the prosperity now enjoyed to improve the railways in every direction, even at the expense of dividends to the stockholders. The most prosperous lines have introduced on parts of their line the most up-to-date system of automatic train signalling, and, where this system exists, it would be difficult for the most captious critic to say that as great precautions are not taken for the safety of the travelling public as are to be found on any railway in the world. The majority of the railways, however, are still unable to afford these measures of safety, and even those railways which have adopted them have only been able to do so as yet partially. Such railways, therefore, continue to take risks.

Risks taken minimised.

247. It must not, however, be supposed for a moment that although American railways take risks, they are in any way reckless in their methods, or that the management are in any way indifferent to the safety of the travelling public. On the contrary, safety is the thought uppermost in the mind of every employee. The sense of individual responsibility, the strong *esprit de corps*, the spirit of emulation, careful supervision, the judgment of every employee by Results, a judgment which is not lax or wanting in severity, are all factors which help to minimise the risks which are taken.

Wisdom of policy.

248. Nevertheless the risks do exist, and the only question is which is the best policy—risks and good to the multitude, or, no risks and good to a small number. Every country must naturally answer this question for itself. America has answered it, so far as the past is concerned, by taking the risks, and is now reaping the benefits of her policy. But whether the time has not come for an abandonment of that policy, on her more prosperous lines at all events, is a question.

On two or more track lines goods trains not worked to Time Table.

249. While, however, the safe conveyance of the passengers receives every consideration, the duplication of the tracks, with the increase in business which this necessarily implies, has led American railways to discontinue, on sections with two or more tracks, the practice of working their ordinary goods trains ("Fast Freight" are always specially treated) to a Time Table, and ordinary goods trains, on two or more track sections, are now started off when they are ready, and are expected to get to their journey's end in the best time they can make, and to keep clear altogether of passenger trains and all trains of a superior class. While the closest check is exercised over passenger trains, goods trains seem to be no one's special care, and, so long as they don't delay passenger trains, it does not seem to much matter how long they take on their journey; and their movements, though posted up in the Train Despatcher's sheet, are notified by the Telegraph Operators often only when time can be found to do so.

Business too great for system.

This change in practice can only mean that, on the busy roads at all events, the business has grown too big for the system. No one in America would of course admit this. They are as proud of their Train Despatcher as they very rightly are of their country. But, while it must be admitted that the Train Despatcher system has done good service in its day, it seems difficult to avoid the conclusion that no business on a large scale can be conducted with as much economy as is possible, without method; and there cannot be method, where goods trains are permitted to work on the "go as you please" principle.

Goods trains longer on road than necessary.

250. I have before me while I write, the record of a day's work of a Train Despatcher on one of the lines in America. His district was 36 miles long, part of which was two, part three, and part four-track lines. The day happens to be a Sunday, when there were fewer passenger trains running than usual. I find goods train after goods train hung up on the road and taking twice as long on their journey as others. If on a district covering 36 miles the delays are so great, on an engine's run they must be considerable. The delays may, under the circumstances, have been quite unavoidable, but the question is whether it is in the interests of good management to start trains off on a journey which they cannot complete in less than twice the normal time. If trains must start when they are started, to be able to get off at all, the delays might still be avoided by working them on a definite time table, and by the adoption of the expedients for the prevention of delays, which would suggest themselves when the time table was under preparation. But, judging by my own experience, I feel sure that investigation would show that a very large percentage of the delays were avoidable, and the reason for this is not far to seek.

The preparation of a time table is work which requires very special training, and it is only after years of practice that men get expert in the business. This being so, it is unreasonable to expect the guard of a train, however capable he may be, to arrange his crossings and passing points with that degree of nicety which will prevent his delaying passenger and fast goods trains, and at the same time avoid delay to his own train. For one delay he is held responsible, for the other, he is not; and he naturally takes the line of least resistance.

Congestion and blocks probably due to lack of system.

251. Where the whole tendency in America is to systematise every branch of the business, and to build up a pratical working system in which every man knows his place and what he has to do, it is all the more remarkable that the ordinary goods train service should have been left to work out its own salvation; and it is more than probable that it is to this more than to any other cause that half the congestion and blockades in America during times of pressure are due. Where there is no method, regularity cannot be expected; and where there is no regularity, the result must be confusion leading to congestion, when the railway's powers are being taxed to breaking point to carry the business offering.

AUTOMATIC TRAIN SIGNALLING.

Automatic Train signalling.

Westinghouse Electro-pneumatic and Hall Electro-gas.

252. I said in paragraph 246 that some railways had introduced on parts of their line the most up-to-date system of automatic train signalling. Of these systems there are many on the market, but I had an opportunity of examining only two, the Westinghouse Electro-pneumatic on the Pennsylvania Railroad, and the Hall Electro-gas system on the New York Central and Hudson River Railroad. I am not an Engineer, and I could not, therefore, compare the two systems from a mechanical point of view. They are both suitable for trains moving in one direction only and, therefore, inapplicable to single track lines. Both systems employ a track circuit, which is operated by a battery at one end and a relay at the other, the current being carried through the rails, which are connected together at the joints by specially-prepared wires. When a train (or a vehicle) enters a block section, the wheels short-circuit the current which causes the signals protecting the section to assume the danger position and to remain in that position so long as there are a pair of wheels in that section.

Difference between the two systems.

253. The difference between the two systems is that in the Electro-pneumatic, the signals are operated by compressed air, which requires the provision of a power-house at intervals of about 25 miles, with the necessary pipes to the signals; while in the Hall Electro-gas, liquified carbonic acid gas is used for operating the signals and the whole apparatus for actuating them is at the foot of the signal post, thus dispensing with the necessity for a power-house and piping.

The Westinghouse system is consequently costly to instal, and, I was told, expensive in operation for a line with less than four tracks.

Both systems afford same protection.

254. Both systems afford the same protection to trains, that is, they give a whole block interval between two trains (on lines with very heavy gradients the interval is two blocks), and, apart from the question of cost, there is nothing to choose between them. They are both excellent, and were spoken of with high praise by the respective roads using them.

Track circuit system works all right in marshy country.

255. Damp marshy country has not been found to adversely affect the working of these track circuit systems, so long as the rails are kept sufficiently free of mud and ballast to allow of a 2-ohms resistance being obtained between the two rails of the track.

Westinghouse system put to a severe test.

Trains worked without interruption.

256. The Westinghouse electro-pneumatic system was put to a very severe test on the Pennsylvania Railroad in 1902. In the spring of that year a severe blizzard passed over a large tract of country where the system was in operation, blowing down poles, wires, and trees, and interrupting all telegraphic and telephonic communication for four days. The signals were fortunately not blown down, and during these four days there was not a single failure of the electro-pneumatic system, and trains were able to be run to time during the whole period, while on portions of the line where the automatic system had not been provided, there was most serious delay and confusion.

Automatic system tried on single lines, but not advocated.

257. An automatic system of train signalling has been devised for single track lines by the Westinghouse Company, and while it is good, I was told that if the traffic is so heavy as to warrant installing the system, it is considered more economical to double the line.

Electric Train Staff for single lines.

258. While on the subject of automatic train signalling, I should mention that the Westinghouse Company (Union Switch and Signal Company of Pittsburg, Pa.) have devised an elaboration of the Webb and Thompson

Electric Train Staff, which permits of its employment for controlling a dead-end siding between two stations which it is not considered necessary to make into a regular station. The guard of any train requiring to work in the siding is given a special staff which opens and locks the points, and until the points are locked and the staff put back in the special instrument at the siding (the staff cannot be withdrawn from the points unless they are locked for the main line), no other staff can be taken out of either of the instruments controlling the section. When the guard wishes to bring his train out of the siding, he calls up the station to which he wishes to proceed. If the line is clear, he is permitted to draw out the staff he placed in the instrument, and can then let his train out of the siding. The road remains blocked until this staff is restored to one or other of the instruments.

Trains following also possible.

The same instrument is designed to permit of train following, there being a series of staffs which can be issued in sequence to trains moving in the same direction. The last train must take all the remaining staffs and until *all* of them are inserted in the instrument at the other end of the section, a staff cannot be taken out from it for a train moving in the opposite direction.

Use of, for banking engines.

It is further designed to permit of the extraction for a banking or pusher engine, of a special staff, which must be put back into one or other of the instruments controlling the section before the section can be cleared for another train. Under this arrangement, the engine can return to the station it started from, from any point between the two stations, and need not, therefore, go any further than is necessary for the performance of the special duty it is engaged in.

WORKING OF FOUR-TRACK LINES.

Four-track lines.

Outer lines reserved for passenger, inner for goods, or *vice versa*.

But lines in one direction are really used promiscuously.

259. In operating four-track lines in America, the practice is, where there are not many sidings to manufactories along the line, to use the outer lines for passenger and the inner for goods trains. Where there are manufactories, the outer lines are used for goods and the inner for passenger trains.

But though one line is called the passenger and the other the goods, they are not exclusively reserved for these services. The general principle is to use whichever track happens to be available, and not restrict the use of either track, the two lines being used promiscuously according to the exigencies of the service. The goods line may be used for taking a fast passenger round a slow passenger, or the passenger line for taking a fast goods round a slow goods, or for taking on a slow goods when the other line is occupied. This is only rendered possible by reserving the two adjacent lines for traffic moving in the same direction, and the practice of using two lines exclusively for passenger and two for goods or two for fast and two for slow trains, and keeping them separate one from the other is now recognised as highly uneconomical.

Passing points always protected by telegraph and interlocked with signals.

Operator in office directs which line train is to take.

260. The passing points, that is, the points at which a train may pass over from one line to another, are always located at telegraph offices, and the points are interlocked with the signals and always remain at danger.

Controlling the line between two telegraph offices, in sections worked under automatic block (there are several block sections between these offices), there is at one end a senior and at the other end a junior telegraph operator. The former decides and notifies the latter when trains are to go off their own tracks and where they are to pass back on to their own lines again. Where a goods train is required to clear the way on its own track for a passenger train to pass, the Train Despatcher notifies the Guard, and he has to get out of the way at the point ordered. If there is a siding there, he goes into that; if there is not, he goes on to the opposite track, and protects his train until it can come back again on to its correct line.

261. Passing points from track to track are not provided too lavishly, so as to keep down the number of facing points; and when wagons have to be delivered at places off the opposing track, where such passing points do not exist, they are taken forward till such a point is reached and sent back from there.

Passing points not too frequent.

262. On four-track lines, when necessity arises, it is not unusual to turn a train on to the opposite track, that is, an up train on to a down track and *vice versâ*, and to allow it to run on that track to the next station. The justification for the practice was that four lines existed and if one was lying idle, it was ridiculous to refrain from using it to avoid delays, when this could be done with perfect safety.

Opposing lines also used when necessary under orders of Train-Despatcher

This practice, I was told, is not confined to four-track lines, but is followed daily on two large double-line systems, the reverse line being used without hesitation when it was unoccupied.

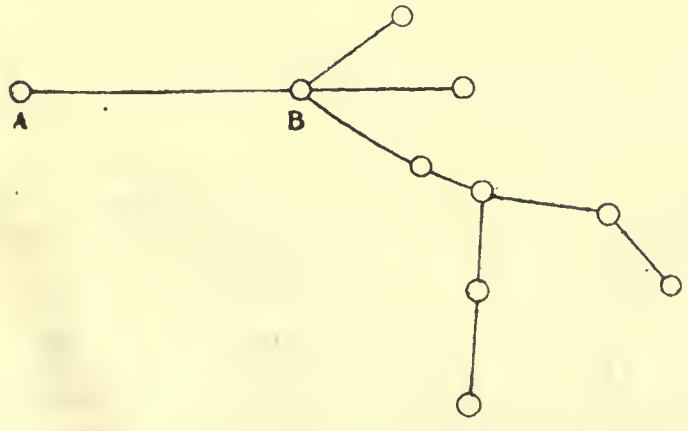
This is, however, never done except under the orders of the Train Despatcher. He notifies the telegraph operator to hold back opposing trains till the particular train or trains have passed, and on receipt of his acknowledgment, the Train Despatcher gives orders to the train staff, an order which both the engine-man and the guard are required to sign for, that they are to proceed between certain points on the wrong line.

The train, while on the opposite track, of course moves without semaphore signals (where such exist) to guard and guide it, but it has its written orders and, with the precautions taken, there should be no danger. The practice is, after all, only a temporary suspension of double or four line working, such as has always to be made when an accident blocks one of the lines, and its adoption must appreciably increase the carrying capacity of a line.

Practice increases capacity of line.

TELEPHONE—USE OF, FOR TRAIN SIGNALLING.

263. The telephone, in place of the Morse sounder, has not so far found extensive use in America for purposes of train signalling, but it is not unusual to work branch lines to colliery and other sidings with them. On one of these branches, 30 miles long, there are nine stations, arranged as follows:—



None of the stations has any staff, but at each of them there is a telephone, a key to which, as well as to the points, is supplied to the guard.

At A, which is the junction with the main line, there is a Train Despatcher, and the movement of every train going to or leaving any of the stations on the branch is controlled by him.

As each train arrives at a station on the branch, the Conductor telephones the Train Despatcher, and gets his authority for his next movement. He thereby acts as telegraph operator and Station Master at the other end, the Train Despatcher being at one end. Once a train has entered a siding at a

station, it may not come out again without the Train Despatcher's authority and while it is there, the Train Despatcher knows he can move other trains over the section.

The branch is on gradients varying from 1 in 25 to 1 in 50, there being no gradient less steep than 1 in 50. On the last section of the line between A and B, which is six miles long, 25 trains run each way daily, bringing out from 12 to 15 thousand tons of freight, chiefly coal and lumber.

This arrangement has been in operation for 10 years with such great success that the use of the telephone for operating branches is being extended.

SIGNALS

Signals. Practice not uniform.

264. As previously noted, semaphore signals are not in common use in America, and where they are provided there is no uniformity of practice. Every railway has a different style of signal. They vary not only in colour and shape, but also in significance. Efforts have been made to try and harmonise the practice on all roads, but so far without success.

Three-position signal used instead of two on same post.

A form of signal that is simple and may prove economical was a three position signal which is used to take the place of the distant and home when they have to be on the same post. When the blade is in the horizontal position it means danger; when at an angle of 45 degrees, home signal down, distant danger; when at an angle of 15 degrees both signals down. The object of the 15 degree position is to ensure the exhibition of a signal, so that if the arm happens to be blown off or removed, the engineman may not be misled. At night the signal shows red, green over red, and green, in the three positions respectively.

TRAINS, MARSHALLING OF.

Making up of goods trains.

265. The common practice is for the loads of goods trains to be calculated on the tonnage basis, but this is being done away with as experiments are completed, and the load calculated on the draw-bar-pull as that gives a much better load behind the engine.

When trains are being prepared, effort is made to get loads for one station, and failing this, for the furthest distance possible. Once the load is made up, whenever it is possible to arrange this, it goes straight through to destination without being disturbed or broken up *en route*.

Over heavy gradients helpers and pushers used.

266. Over very heavy gradients the number of engines on the train is increased so as to help the train over, and in one place I saw four engines, two in front and two in rear, taking a train over a 12 miles long gradient of from 1·8 to 2 per cent.; and I was told this was the daily practice. At the summit of the mountain there is a tunnel in which the gradient changes from rising to falling. As the train gets over this hump the forward engine detaches while the train is still in motion, and runs ahead into a loop, the rear engines doing the same thing. The points leading to this loop are operated from the signal tower, and are set for the loop as the train passes the hump, intimation of which is automatically indicated to the signalman. Similarly, when the crossing has been cleared, an indicator in the tower shows this, and until it is cleared, the signal controlling the train cannot be lowered.

Marshalling of trains; suitable yards provided to facilitate work.

267. For the expeditious marshalling of trains, special shunting yards are provided, with receiving lines, sorting sidings, classification sidings, and departure lines. These yards run into several miles of sidings, and one now under construction is to have 100 miles of them. To provide it, a bank 67 feet high in some places, and 40 feet high in others and many feet wide, has had to be removed, but the expense is not considered unreasonable for the facilities which will be afforded. I do not attach any diagrams of these yards, as several of the best types were communicated early in 1903 to the railways in India in a Technical Section Paper.

Some of these yards are laid on the level; some are gravity yards on the plan of the Edgehill Yard on the London and North-Western Railway, near Liverpool; but the latest type is a gravity yard with a hump a short distance from the points leading to the sorting sidings over which the wagons are pushed by an engine.

Gravity yard with a hump considered most suitable for American conditions.

268. This last type of yard has been adopted in supersession of the Edgehill type so as to permit of the rakes of vehicles being dropped over the hump at equal distances apart, and so as to prevent their being on the descending grade long enough to get up speed. These difficulties seemed to be equally applicable to the Edgehill Yard, and I went there specially to see how they were overcome there. The difference would seem to be due to the position of the brakes on the wagons. The brakes in the English wagon are on the sides, and all are pinned down as the train is brought to a stand on the gradient. When the marshalling begins, they are released as each rake of vehicles is detached. If they are going too fast, the pointsmen can pin them down again as the wagons pass the points (all the points are operated manually). In America, the brakes are operated from the roofs of the wagons, and each rake of vehicles has a brakesman whose duty it is to move from vehicle to vehicle along the roof and control the speed; and there is the danger, when the engine is detached, of the vehicles rolling back and getting up high speed before the brakesman can get at the brakes to control them. The danger has been increased with the heavy types of wagons now in use.

The hump type of yard necessitates the employment of an engine for shunting purposes, and is consequently more costly to work than the ordinary gravity yard.

Fly shunting not approved of.

269. Fly shunting, the practice universally followed in India, is disapproved of, because of the great strain on the wagons when suddenly stopping, and is rarely practised.

Method of operation in level shunting yards by poling.

270. Where gravity yards do not exist, the shunting is done by "Poling." The rake of vehicles to be shunted stands on one track; the engine which does the shunting stands on an adjacent track. To it is attached a small truck, on which is fixed a pole. This pole is swung out and placed against the corner of the last wagon in the rake to be moved; the engine is then put in motion, and stops when the wagons have sufficient way on, and goes back for another rake. The system is much more expeditious than the Indian system of fly shunting, and, under it, it is possible for two engines to be working on the same rake of wagons from the lines on either side of them, so that shunting can be done in very much less than half the time which fly shunting would require.

Shunting expenses in America.

271. As the brakes in America are operated from the roof of the cars, a very large supply of brakesmen has to be maintained for shunting purposes, and this supply very soon gets exhausted. To bring them back, an engine with a carriage attached to it, has to run up and down the yards, the distance travelled by it sometimes being as much as $1\frac{1}{2}$ miles. The position of the brake, therefore, makes all shunting operations in America very costly.

Marking of wagons, &c.

272. To expedite shunting operations, in anticipation of the arrival of a train which requires to be passed through the marshalling yard, a telegram

is sent the Yard Master giving the order of each wagon from the engine, and its destination. A copy of this is given to the man in the signal-box with each "cut" shown, that is, with the lines marked on to which each rake will be shunted.

Immediately the train arrives, a man goes round and marks the wagons for the different sidings in the classification yard. All wagons have their numbers marked not only on the sides *but on both ends*, so that the mark can be placed on the wagon without going to the side of the wagon to see its number. They are then separated and the brakesman signals to the signalman for which line the wagons are destined, and the latter sets the points accordingly after verification of the signal with the telegram sent him by the Yard Master. In hump yards there are "car droppers" who detach the rakes as they pass over the hump.

Points operated by electricity.

273. In the most modern yards, the points are operated from the signal cabin by electricity, and immediately the crossing is cleared this is indicated in the cabin. The signalman is, therefore, able to prevent accidents from the fouling of crossings.

Card way-bills show weight and draw-bar-pull, and when load complete guard takes train out.

274. To permit of the preparation of the train, the card way-bill or car manifest which accompanies every wagon shows the gross weight of car, and rating of engine lading, that is, the draw-bar-pull for that weight when the load is calculated on draw-bar-pull. These way-bills go to the yard clerk who computes the load, taking the wagons in the order in which they stand in the classification sidings. He is provided with a small automatic adding machine (I neglected to note the name of the machine, but the Government of India obtained a couple of them last year to try), and on this he marks the draw-bar-pull of each wagon until the total reaches the full rating for the engine. He then makes over the card way-bills for these wagons to the guard who makes up his train from them; and as all wagons couple automatically he has no trouble in doing so.

System devised to expedite work and save labour.

275. The whole system of marshalling and of making up trains is designed to permit of the work being done with the least amount of effort and in the quickest possible time, and a train can be marshalled and got ready to go out in less than ten minutes, while with the old methods an hour is not often sufficient for the marshalling of a single train. The economy of the arrangement does not need much demonstration.

PASSENGER TRAIN YARDS.

Passenger Yards.

276. The yards in all modern passenger stations are laid out with the same scientific skill, and, when re-building, no expense is spared to get yards which can be operated with expedition and safety.

Boston South Terminal.

Appendix B.

277. The Boston South Terminal was the largest and best type of such a yard which I saw. It has 28 passenger platforms; a large yard consisting of 24 tracks with an equal number of short platforms where the Express and Government Postal business is handled; and another yard where the cleaning of carriages is done. To complicate matters, there is a draw bridge within the limits of the yard.

The diagram (Appendix B) will convey a clearer idea of the plan of the yard. It contains 37 double slip points, 252 sets of ordinary points, 283 movable frogs, and 148 semaphore signals. All these are operated by 143 levers located in one tower, and the points and signals are interlocked on the electro-pneumatic system, as designed by the Union Switch and Signal (Westinghouse) Company, of Swissvale, near Pittsburg.

Trains from six different points enter the station, and the number notified to run regularly in and out is 833 daily on week days. As in America no train, not even a short suburban train, is ever allowed to go out again until it has been thoroughly cleaned, and this cleaning is always done away from the passenger platforms, this means that there are a minimum of 1,666 train movements daily in the Passenger Yard alone. This traffic is handled without any confusion or delay, and, I may almost say without any accidents, practically within 18 hours.

1,666 train movements daily.

The cost of constructing this yard was, of course, enormous, but experience has shown that the outlay was one of those economical extravagances which have been more than justified by the results.

Cost of construction amply justified.

CHAPTER IX.

GOODS TRAFFIC.

OUTWARDS GOODS.

Mutual confidence between railway and its customers the rule.

278. The mutual confidence which is shown between employer and employee is also shown in the business relations between the railroad and its customers in connection with goods traffic. Loss sometimes results from this policy, but the gain is so immeasurably greater, that the tendency is to reduce the checks, not to increase them. The consequence is that the handling of the large volumes of traffic which have to be dealt with, is greatly facilitated and expedited.

Traffic consigned in car or less than car loads.

279. Goods traffic in America, as previously explained, is consigned in either car load or less than car load lots.

280. For car load traffic, the railway places wagons in the sidings set apart for this purpose, which always have a roadway for carts on one side of them, and consignors load their own goods and attach their own seals.

Form of receipt used.

281. After the loading is completed, the railway takes over the wagon and signs and stamps with the railway stamp the receipt presented by the consignor. It is prepared in duplicate with the aid of carbon paper, and the railway retains one copy as the forwarding or consignment note. This receipt (the condition at the conclusion of which that the railway "will not carry and is not liable for loss or damage occurring beyond its own lines," will be explained later on), is in the following form, details of course differing on the several railways :—

ORIGINAL.

_____ Station, _____ 190____.

RECEIVED FROM _____

_____

by the _____ Railroad Company, the following goods, in apparent good order, to be forwarded subject to rules and conditions contained in the Bills of Lading, Classifications and Tariffs of this Company, and upon the express condition, that it will not carry and is not liable for loss or damage occurring beyond its own lines.

☞ **This Receipt may be exchanged for a regular Bill of Lading.**

Consignee _____

Destination _____

_____

Viâ _____

CLASSES.	1st.	2nd.	3rd.	4th.	5th.	6th.
WEIGHTS. SUBJECT TO CORRECTION.	A	B	C	D	E	

NO. PKGS.	DESCRIPTION OF ARTICLES.	WEIGHTS.

_____

Railway Agent.

AGENT'S STUB.

_____ Station, _____ 190____.

Delivered to the _____ Railroad Company,

by _____

_____

as described below. Freight to be forwarded, subject to rules and conditions contained in the Bills of Lading, Classifications and Tariffs of the Company, and upon the express condition that it will not carry and is not liable for loss or damage occurring beyond its own lines.

Consignee _____

Destination _____

_____

Viâ _____

CLASSES.	1st.	2nd.	3rd.	4th.	5th	6th.
WEIGHTS. SUBJECT TO CORRECTION.	A	B	C	D	E	

NO. PKGS.	DESCRIPTION OF ARTICLES.	WEIGHTS.

_____

Shipper.

Wagon weighed and Agent's Stub sent to office for preparation of invoice.

282. The wagon is then passed over the scales, the weight ascertained, and the "Agent's Stub" sent to the Goods Office with the weight shown thereon, for the preparation of the way bill or invoice.

These scales ase usually automatically worked, and the wagons are run over them as fast as they can go, the line leading on to the scales being on a falling gradient to facilitate their rapid movement. The automatic machine I saw was supplied by the Streeter American Automatic Weight Recorder Company of Chicago, Illinois.

Consignors are not furnished with the weight of their goods unless they specially ask for this information to be recorded on the receipt.

Procedure at private sidings.

283. The same procedure is followed in regard to wagons loaded at private sidings, except that the guard of the train who removes the wagon or wagons from the sidings gives the receipt on behalf of the Agent.

Procedure at out sidings.

284. When the wagon is from a siding on the line, the owner of the siding sends particulars of the wagon to be moved to the station next before his siding is reached by the train which will take it on. The Station Agent there prepares a "car manifest," on which are shown the name of consignor and consignee, stations from and to, and route, weight of car empty, its contents and gross weight as stated by consignor, and, if the load of train is calculated on draw bar pull, the "rating" for engine, and hands it to the guard, who then picks up the wagon, and has it weighed at the first station where weighment is made.

285. In the ease of all ear-load traffic, the wagon is always accompanied by a Car Manifest, whieh remains with the car until it reaehes its destination, and the invoice for the ear is sent on direet to the station of destination to which the wagon is billed. Such cars are not usually labelled, unless it is a foreign car, when a label is attached showing junetion from whieh received and to whieh to be returned.

Car manifest given for every wagon with car load traffic.

286. All ear load traffic is earried by slow trains, whieh travel at from 10 to 15 miles an hour, because of the lower rates eharged for it, and the wagons when loaded are removed to the elassification yards and are there marshalled and made up into trains, whieh leave as soon as loads are ready.

Car load traffic carried by slow trains.

287. For traffic in less than car loads, sheds with platforms are provided, which are usually elosed in on both sides, but have doors at close intervals. The platforms are raised to the level of the cart in ordinary use, and the earter baeks his cart against the platform, and with the aid of the railway porters unloads the goods on to hand barrows. Goods are not required to be brought to any particular door for particular stations, but are reeeived at any door eonvenient to the carter. This saves delay in the taking over of the goods, though it often increases greatly the distanee they have to be carried to the wagon.

Less than car load traffic.

288. Sueh goods are marked by the eonsignor with the name of the consignee and station of destination. The railway adds no further marks of its own, nor does it require any marks other than those mentioned from the eonsignor. Where the package cannot be eonveniently marked, the address is written on tags, which are tied on to the package.

Only consignee's name and station of destination marked on goods. Railway puts no marks.

Opposite eaeh door there is a weighing scale sunk in the ground to platform level. The hand-barrow is run straight on to this scale, and the weight of the eonsignment called out to a clerk in the offiee alongside the scale. If, however, the goods are of a standard kind, like barrels of flour for example, the weight of whieh is known, weighment is dispensed with.

With the eonsignment the carter presents a reeeipt in duplicate, similar to that described in paragraph 281, which the elerk in eharge of the scale signs and stamps with the railway stamp, endorses the weight if desired and returns, retaining the Agent's Stub for the station reeord.

Carter presents forwarding note in duplicate, one copy returned as receipt.

This eompletes the transaction with the consignor.

289. For the expeditious handling of outward traffic, the arrangements at the Chieago station of the Illinois Central Railroad are as follows :—

Arrangements for expeditious handling of traffic.

Running parallel with the goods platform are seven lines, whieh are laid only far enough apart to permit of a man walking between them with safety. These lines hold, six of them 41 ears each, and one 22 cars, or a total of 268 wagons. During the night, the yard staff fill these lines with such a number of wagons as the traffic of the season demands, so placing them that the doors of the wagons on all seven lines shall be direetly opposite eaeh other.

Eaeh one of these wagons is assigned to a separate station, or group of stations, aeeording to a printed schedule, and the wagons are plaeed in the lines in the order shown in this schedule. The wagons are arranged in the schedule in the order in whieh they would stand on the train when marshalled, and the rakes are arranged on the lines in the order in whieh the trains leave, that for the first train being on the seventh line, that for the seeond train on the sixth and so on. The load for a train being only 28 wagons, and the lines holding as many as 41 cars, the rakes are arranged, so as to permit of the trains being made up by drawing out one

Wagons allotted to stations before loading commences and marshalled ready to go out on train.

lot and attaching it to the remainder of the train without disturbing the other wagons in the line.

The wagons are further arranged so that those containing goods for grouped stations shall be on the train which stops at the last stopping place before these stations are reached, since the trains by which this traffic travels only stop at division points and junctions.

Numbers of wagons furnished each Clerk.

290. The number of each wagon in each line commencing from the rear is then taken to the office, and transferred to the printed schedule, which shows the line and the row in that line on which each wagon for each station stands. Copies are then struck off by means of the hektograph reproducer for the several scale clerks, and a complete list of the wagons with their destinations is supplied to each.

Wagons allotted according to amount of traffic.

291. In the assignment of these wagons to stations, such stations as usually receive a wagon load of less than car load traffic have a wagon allotted entirely to them. For the remainder, groups are formed of adjacent stations in suitable numbers, and a wagon allotted to each group.

Minimum load allowed, 2½ tons.

292. The minimum load usually allowed for a wagon of miscellaneous traffic is 2½ tons, but if empties are moving in the direction of the traffic as little as one ton is allowed to be loaded. If a suitable load is not available for any wagon, the contents are unloaded and transferred to another wagon or kept over for next day, the empty being detached when the train is drawn out later.

Opposite each row of wagons, number of row shown.

293. Opposite the door of each wagon on the platform line the number of its row is entered, and in the case of wagons for groups of stations a list of the stations in the group is hung up in the wagon while loading is going on.

Wagons in each row connected up by gangway.

294. On commencement of the day's work of loading, the porters lay a gangway, which is usually a thin metal sheet, between each pair of wagons so as to make a through road from the wagon on the first line to that on the seventh. The wagons are now ready to be loaded.

Clerk in charge of each row.

295. In charge of each row of seven wagons there is a loading clerk who is responsible for seeing that the goods are for his row of wagons and that they are properly and carefully loaded, and in the case of grouped stations that they are loaded so as to be unloaded easily without disturbing the goods for all the other stations.

Number of row in which wagon stands entered on package.

296. To return now to the consignment, after the weight has been given the scale clerk, he gives the porter the location of the wagon, that is, he tells him in which row the wagon stands, and on which line in that row, thus, 7—3, which means the goods are to go into the wagon standing on the third line in the seventh row. This location the porter records on the packages with chalk, and they are then trundled straight away to their wagons.

All loading done with hand barrows.

All loading is done by means of hand barrows, and the porters are paid at an hourly rate so as to avoid overtime complications. The platforms are made wide enough to allow of two barrows passing each other with loads, and are laid with timber, and the closer the timber is laid the heavier the loads which can be taken on the barrows and the more expeditiously can they be moved. Large loads are in this way taken, and by the use of barrows the traffic is quickly and economically handled.

This completes the process of loading.

Same procedure followed at all stations.

297. The same method is followed at all stations on the line where traffic in large volumes is handled. In the south the labour is often illiterate, but no inconvenience is experienced from this, and the porters are seldom found

to make mistakes. When they do, they are always put straight by the loading clerks at each row of wagons.

298. While the loading is going on, the scale clerk records on the "Agent's Stub" or forwarding note the number of the wagon into which the consignment will be loaded, and sends it up to the goods office, where it goes to the freight clerk, who enters the charges. It is then passed on to the invoicing clerk, who prepares the invoice on an Elliott and Hatch typewriter, making when necessary as many as eight copies of it. The invoice is then checked with the Agent's Stub by another man, who stamps a number on it with a Paragon number stamp. The invoice is next press copied, as many as 18 copies often being made (the reason of this will be explained later). The invoice is now ready to issue. The preparation of the invoices thus goes on simultaneously with the loading of the goods. If all the invoices for the wagon are not ready by the time the train is ready to start, a "car manifest" is sent with the wagon, and the invoices are sent through to destination by passenger train. If they are ready, they accompany the wagon. In the case of grouped wagons, a special effort is always made to send the invoices with the wagon.

Scale clerk records weight in forwarding note, and passes on at once to office for invoice to be prepared.

Invoices accompany goods.

299. Less than car load freight is charged high rates, and is treated as high-class freight and is always sent on by fast goods trains, which are timed to run up to 35 miles an hour, according to the distance which they have to travel before daylight.

The first train, that for the farthest distance, is due to leave at 5.15 p.m., and the last one, that for the nearest distance, at 8.25 p.m. Usually there are nine trains altogether of 28 wagons each, which stop only at division points and junctions.

Less than car load traffic sent by fast trains.

300. The loading of these trains goes on up to within 25 minutes before the due time of departure. The wagons are then sealed with wire seals, each of which is numbered, and the number recorded by the guard in his report, and labels showing the destination of the wagon are *nailed* on to the side. On many railways no label is affixed to the wagon, but a "car manifest" accompanies it, on which are shown the station from and to, route, consignor and consignee, (where the wagon is from one consignor to one consignee), the weight of car, contents, and gross weight, and, where the load of the train is calculated on the draw-bar-pull, the rating for this gross weight.

Work goes on to within 25 minutes of train's due departure.

Wagons sealed with wire seals.

301. Immediately the sealing and labelling of the wagons are completed, the wagons are coupled up (they couple automatically), and the engine of the train attaches on, and draws it out into the departure yard, where the caboose or brake van is attached. As previously explained, the wagons are loaded in marshalled order, so that no shunting is necessary, unless there is an empty wagon in the rake which requires to be detached.

Wagons drawn out into departure yard, as no shunting necessary.

302. In the meantime all the invoices, or "car manifest," as the case may be, for the wagons are sent direct to the departure yard, and the guard takes over charge there and starts his train.

Guard takes over in departure yard.

303. The greater part of this traffic is for stations up to within 300 miles of Chicago on the main line, which is about the distance covered by the Chicago market for retail goods. Points further distant draw their supplies from other large cities, which are served by a similar system to that obtaining at Chicago. Goods in wagons for one station reach their destination by 7 o'clock next morning; those for grouped stations before nightfall.

Stations within 300 miles served within 24 hours.

304. In the case of this grouped traffic, or what in India would be called section road goods, the wagon containing them is detached at the first station

How section road goods dealt with.

in the group, which is a divisional point or junction. At this station the wagon is opened, goods for the station unloaded, wagon rescaled for the next station for which it contains goods, and attached to the "local" or distributing goods train, which is timed to leave after the fast goods train has arrived, though not usually before daylight. At each station for which there are goods, the wagons are opened, the goods unloaded, and the wagons re-sealed and sent on by the same train. The unloading is done by the guard and brakesmen, of whom a sufficient number are sent with the train. It is not unusual for there to be 15 to 20 such "local" trains depending on the fast goods trains, and running in connection with them. Of course, they distribute all the wagons for the section, as also the road goods received from other parts of the system and pick up traffic from these stations.

Traffic handled daily at station.

305. The traffic in less than car-load lots, loaded at the Chicago station on the 29th of September 1903, the day I visited it, amounted to 15,522 different consignments, for 1,920 different stations, and weighed 1,024 tons of 2,240 lbs. each, and was loaded in 202 wagons, giving an average load for each wagon of 5 tons.

For the first half of the year 1903, the traffic in less than car-load lots loaded at this same station averaged daily—

Tons loaded	988
Wagons used	195
Average load per wagon	5·2 tons.

Invoices only prepared to junctions, where freight is paid by next railway and fresh invoice issued.

306. In paragraph 281 I said I would explain later the condition in the receipt that the railway "will not carry and is not liable for loss or damage occurring beyond its own lines." Except in special cases, the practice in America in regard to traffic going on to foreign roads, is to invoice the goods to the junction with that road only. The invoice, in addition to columns for the usual information, has columns to show through rate, freight charges, and advanced charges. The station of origin shows, in the column of through rate the freight chargeable for the whole distance, and in the column freight charges the proportion due to the consigning railway. On arrival of the goods at the junction, the agent of the forwarding railway there issues a "freight bill," (which will be explained when dealing with inwards goods), to the agent of the railway on to which the goods are going. The latter pays the freight due the forwarding railway, takes over the goods and issues a fresh invoice to destination or the next junction, showing the through rate as before, and entering in the advanced charges column the amount paid out to the forwarding railway, and in the freight charges column his railway's proportion of the rate. The same procedure is followed at every junction until the last is reached, each railway paying out the charges paid by and due to the last railway before the goods are delivered up.

The invoices are checked in the Audit Office, and mistakes intimated often before the goods have reached the junction, but where they have already been delivered, and the agent at the junction has not discovered the mistake, the sums are adjusted between the two agents by under and over-charge sheets. But under the very simple system of charging for goods, there are not often mistakes.

Clearing House established by some railways.

307. The practice was, no doubt, the outcome of the financial insecurity of railways until a few years ago; but things have so much improved in recent years, that several of the railways, recognising the extreme inconvenience of the arrangement, have established a Clearing House at Buffalo, where all through invoices (both local and through of some roads), even between adjoining railways are dealt with. In the case of railways parties to this Clearing House, the invoice only shows the through rate and the division is made in the Clearing House.

308. To expedite the preparation of statistics, the station issuing an invoice sends a tissue copy of it to the Auditor on the day of issue. Where, in special cases, or in the case of Clearing House stations, invoicing through to destination is permitted, a tissue copy of the invoice is sent by the issuing station to the Auditor of every road over which the traffic will pass. This is the only copy the Auditors receive. The original, with rare exceptions, always remains with the station of destination as its record.

Auditor only receives tissue copy of invoice.

309. In certain cases, tissue copies of invoices are also sent to the Traffic Manager and to such of the Divisional Traffic Agents as may be interested in the traffic. This explains why sometimes 18 copies of an invoice are necessary. The labour of preparing these copies is merely mechanical and is not great, and the general saving of time, and the expedition of business, which result from the Auditor being satisfied with a tissue copy of the invoice, cannot be exaggerated.

Tissue copy of invoices also sent to Traffic Officers.

310. In connection with the outwards traffic, it should be mentioned that some railways only permit their wagons to go on to foreign railways when they can spare them. This is largely due to the fact that under the old system of paying mileage only for wagons on foreign roads, the wagons were delayed indefinitely, often dishonestly; but now that the "per diem" charge has been introduced, and "Car Service Associations" have been formed to see that wagons are not improperly delayed on foreign railways, the objection to letting wagons go on to foreign railways is not so great. Where scarcity of stock necessitates the refusal, the railway on to which the traffic is going, is permitted to send its own wagons for the traffic, and to receive payment at the regular per diem rate of 20 cents., or 120 pies per wagon per diem for the time the wagons are away from the home line; and railways are only too glad always to secure traffic in this way rather than not have it at all. When, however, they refuse to send wagons, the wagon is, in such cases, booked to the junction, where the contents have to be transhipped.

Some railways permit their wagons to leave line only when spare.

INWARDS GOODS.

311. To study the method of dealing with inwards goods traffic, I visited the Boston Freight Terminal of the New York, New Haven, and Hartford Railroad, which was reported to handle a larger inwards business in less than car load lots than any other single station in America.

Inwards goods.

There are nine sheds or freight houses at this station for less than car load traffic, which vary in size from 300 ft. by 28 ft. to 1,000 ft. by 60 ft. These sheds are divided up among different consignees or different groups of stations, and goods for one consignee or from one station are unloaded in the same shed always whenever this is practicable.

Nine sheds for inwards traffic in less than car load lots.

312. On arrival of a train, a clerk takes over the invoices from the guard and marks the several wagons containing less than car load traffic for the different sheds opposite which they are to be placed, car load traffic being marked for the different sidings where such traffic is unloaded by consignees. The clerk then takes the invoices to the office, which remains open all the 24 hours.

Clerk marks wagons for different sheds.

313. In the meantime, the yard staff shunt the wagons to their proper places, where they are immediately unloaded, no matter what the hour may be.

Wagons unloading.

The wagon is unloaded in the bay immediately in front of the door (each door is numbered) opposite which it stands, on a "blind tally," that is, a clerk enters the wagon and checks off the contents on a tally slip, recording the particulars of marks on packages.

Inwards Goods.

Para. 314.

Number of door telephoned to office.

As soon as unloading begins, the clerk telephones to the office the number of the door at which the wagon is being unloaded, which number, with the shed number, is entered on the "Delivery Checks," so that consignees may know where to go for their freight.

Each package marked with wagon number and date of unloading.

As each package is unloaded, the number of the wagon in which it arrived and the date of arrival are stamped on it. The stamp is a rough block with four of each of the ten figures, and the necessary figures are inserted in this block in two lines, the top one representing the wagon number and the bottom one the date. No attempt is made to space the figures. Where the package cannot be marked, a tag is secured to it with a metal fastener, on which the particulars are shown.

Immediately the invoices reach the office, the numbers of the several wagons comprising the train are entered up in a register called the Car Record, and this completes the process of unloading.

Invoices audited and passed on to freight bill clerks.

314. In the office, the invoices are audited by the Goods Shed clerks as soon as they are received, and passed on to the clerks who prepare the "Freight Bills" and "Delivery Cheeks," (in one operation, with the aid of carbon paper), the form used being as follows :—

FREIGHT BILL.

_____ Boston, 1903. ____ day of mo. 8 Pro. No. 57518

_____ (_____ Acct.)

_____ Car No. ____ To THE NEW YORK, NEW HAVEN & HARTFORD R. R. Co., Dr.

Transported from NEW YORK *viâ* Stonington Line. W. B. No. ____ Date 8

NO.	ARTICLES.	WEIGHT.	RATE.	CHARGES.
			ADVANCES	
All claims for loss must be made on delivery of goods. MAKE CHECKS PAYABLE TO THE NEW YORK, NEW HAVEN & HARTFORD RAILROAD CO.	Received Payment for the Company. _____		TOTAL. CARTAGE.	

No.

DELIVERY CHECK.

Owner's Team

_____ Pro. 57518 1903, ____ day of mo.

_____ (_____ Acct.)

_____ Car No. ____ Received of the N.Y., N.H. & H.R. R.Co., in good order unless otherwise noted, the following goods :

Transported from NEW YORK *viâ* Stonington Line. W. B. No. ____ Date 8

NO.	ARTICLES.	WEIGHT.	RATE.	CHARGES.
			ADVANCES	
Delivered at Boston Freight Terminals Boston, by ____ on ____ 1903.	(Sign Here) _____		TOTAL. CARTAGE.	

CASHIER'S CHECK.

1903.

8 Pro. No. 57518

315. The Freight Bills are consecutively numbered, beginning with the first figure in the series each month. Series are allotted to groups of stations, 1 to 14,000, 16,000 to 28,000, and so on, according to the number of consignments usually received, and the indents for the forms specify how many of each series are needed for the month to meet the traffic of the season. The forms come numbered from the Supply or Stores Department, and any not consumed are destroyed.

Freight Bills consecutively numbered in series which are allotted to groups of stations.

The Auditing Clerk keeps a note of these checks, and records on the invoice the next number to be issued and that number is issued by the Freight Bill Clerk. Of course, separate clerks control separate sections and so confusion is avoided.

316. After the Freight Bill and Delivery check are prepared, the invoice goes to the Notice Clerks, who issue Arrival Notices when necessary, showing at which Cash Delivery Office consignee should call. (They are only issued to casual consignees and not to regular customers). It then goes to the Car Record Clerk who enters up the number of the check opposite the wagon number. After this is done, the invoice is filed in the office, except in the case of certain foreign line way bills, which are required to be sent to the Auditor, in which case a copy is retained for office record. No copy is made of the invoice at the receiving station in any register.

Invoice goes to Arrival Notice and Car Record Clerks and is then filed.

317. The Freight Bill and Delivery Check in the meantime are sent to the Cashier, or Cash Delivery Clerk, a list of them, with the amounts due, being recorded in a special form and sent to the Accountant (station, not audit office), who keeps a check on the Cashier to see that amounts are correctly accounted for.

Freight Bill goes to Cashier, and list of them to Accountant.

There is only one goods office for all the nine sheds, but there are two Cashiers, or Cash Delivery Clerks, and the Freight Bills are sent to the clerks concerned.

318. On receipt of the Freight Bills, the Cashier arranges them in pigeon-holes, which have glass backs. Where there are many bills for individual carters, they have pigeon-holes of their own, and as they can see through the glass when there are any for them, they do not need to ask any questions. Those who have not their own pigeon-holes, inquire, and are informed.

Cashier places Bills in pigeon-holes where carters can see them.

No receipt is demanded from the consignee unless evidence of identity is required, and in this case the notice of arrival would generally be regarded as sufficient evidence. The receipt given at the forwarding station is never demanded except in very suspicious cases.

Receipts not required to be given up.

There are six men employed in cash delivery for all the nine sheds.

319. At the close of the day, the Cashier prepares a statement showing the number of the Delivery Checks entered in the order of their numbers and the amounts collected, and sends it to the Accountant, who enters up date of payment in the form he received from the Freight Bill Clerks.

Cashier sends statement of takings to Accountant.

At the end of the month the Cashier and Accountant prepare, independently of each other, a list of outstandings, and the two lists are checked with each other.

Outstanding Lists.

320. The consignee on payment of freight receives the portion of the Delivery Check so marked, which he takes to the goods shed and gives up after signing and getting delivery of his goods.

Consignee presents Delivery Check at shed.

The shed delivery clerks are quite independent of the cash delivery clerks, and the buildings are so far apart that there is practically no communication between them.

Shed Clerks independent of Cashier.

Record of all wagons carefully kept.

321. To allow of a correct record being kept of the movement of all wagons, a staff of 23 men is employed, who go round the yard at 6.30 every morning and bring in a complete list of the wagons in it, with the lines on which they are standing. Each man is supplied with ten forms, on the first of which he records all wagons the numbers of which end in 0, in the second all those ending in 1, and so on.

The wagon numbers are then checked up with the "car record" register, and notice taken of any detentions. As each train leaves the station, the numbers of the wagons on it are sent into the office, and the departure of each wagon is entered up in the register.

It is thus possible to keep a complete record of the movement of every wagon, and to trace it easily when any enquiries are made about it.

The number of loaded wagons received at the Boston terminal averages 700 daily, so that the necessity for, and advantages of, the record are apparent.

Traffic between New York and Boston carried by rail and steamer, as water route cheaper to operate.

322. At the Boston Freight Terminal, there is also a large traffic handled to and from New York, which is carried 50 miles by rail and about 175 by steamer. The steamer leaves New York at 5 p.m.; the goods are transhipped to the train as soon as they reach the wharf at Stonington, and are landed in Boston by 9 a.m. the following morning, that is, the journey is accomplished in 16 hours. The traffic from Boston is similarly carried, but leaves Boston at 3 p.m., and accomplishes the journey by 6 a.m. This route is adopted instead of the all rail route, because it is so much cheaper to operate.

CASH REMITTANCE.

Cash remitted to Banks; salaries paid by cheques thereon. Station Agent may cash.

323. On many railways in America, the practice obtains of paying in the station earnings daily to the nearest bank, which in turn cashes cheques issued by the railway in payment of salaries, &c. In the case of railways adopting this arrangement *all* salaries, even that of trackmen, are paid by cheques on these banks, though they may be presented to and cashed by the Station Agent at any station. Any shop or store will accept them in settlement of accounts, and any bank will cash them.

No interest is paid by or to the railroad for such deposits in banks.

Indian practice followed on New York Central.

Money remitted through Express Company.

Cashier signs for covers if seals intact.

324. On the New York, Central and Hudson River Railroad, however, I found the Indian practice followed, of requiring all earnings to be sent to headquarters.

The Station Agent or the Freight Agent, or the Station Agent when he performs both duties, at the close of the day, makes over all his earnings in sealed covers to the Express Company associated with the railway, in this case to the American Express Company. The Express Company carry these covers to New York and deliver them to the Cashier, who signs for them if the seals are intact. Almost all American money is in the convenient form of bills or notes, and can, therefore, be easily packed in envelopes; but when there is silver to remit, each different kind of coin is made up into separate rolls, which are sealed, the amounts being shown on the outside, and the whole packed into one bundle and sealed.

Tellers check with remittance note.

325. The envelopes and bundles are then sorted for and made over to the various Tellers, who open the covers and check the contents with the remittance note which is in the cover, without anyone supervising them in detail.

Each man has a separate counter cut off from the others, and on it are compartments for the notes of different denominations.

If the amount received agrees with the remittance note, the latter is initialled and passed on to a Typist. If there is a discrepancy, the money is recounted and the totals checked. If there still is a discrepancy, it is recorded on the remittance note before latter is sent to the Typist, and the station debited.

Discrepancies noted on Remittance Note.

326. The Typist enters up the receipts against each station in a form under the heads of Passenger, Freight, and Car Rental. This form is prepared in duplicate with the aid of carbon paper. The upper sheet is a solid copy. The lower sheet is perforated after Passenger, Freight, and Car Rental. After the day's work is over, the lower sheet is divided, the Passenger part going to the Passenger Department of the Audit Office, and the balance to the Goods or Freight Department. Each column is numbered Sheet No. 1, Sheet No. 2, and so on, and at the head of each column is placed the date.

Typist enters receipts on a special form which saves much labour.

On arrival in the Passenger and Goods Departments, respectively, the column with the amounts is torn off and pasted on to loose sheets on which the daily earnings for the month are recorded. (The station accounts are balanced monthly), the loose sheets being filed in what are called Perpetual Ledgers, which will be explained later.

This arrangement saves a great deal of labour and has been found to work admirably.

The station returns are of course checked in the usual detail in the Audit Office and a staff of Inspectors is kept who go round periodically and inspect the accounts at the stations.

327. In the Cashier's Office there are no bound registers, and the only record is the cash remittance note and the loose sheets in which the daily earnings are recorded. These latter are, however, filed in Perpetual Ledgers. The reason given for not keeping records in bound books was that they were not original records, and there was, therefore, no necessity for bound registers.

No registers kept in Cashier's office.

328. Nine hundred stations and 250 Passenger Guards remit money daily to the Cash Office in New York, and for the checking of all the money there are employed one Cashier, one Assistant Cashier, five Tellers, and three Typists, or a total establishment of ten people.

Staff employed in cash office.

The Tellers are all bonded for about $3,000 or Rs. 9,000 each. They handle the cash of the same stations always, and if complaints of short remittances are frequent, the Teller is watched ; and if there is no improvement, he is suspended and removed from his appointment. This is practically the only check exercised over him and all that is done to protect the station staff. By making the same Teller handle the money of the same stations always, it is found possible to fix responsibility pretty soon on the person who is dishonest, whether in the Cash Office or at the station.

Tellers bonded, and watched if shortages frequent.

329. When all the earnings have been checked, a statement of the total amount in specie, bills or notes, cheques, and silver of each denomination is prepared, a separate list of the cheques being made on the typewriter, and the whole money sent to the Bank with which the Company deals. A tissue copy of this list is made and is the only record of what has been sent to the Bank.

Remittance to Bank.

Silver is usually sent to the Bank in the rolls in which it was received from stations without being opened, the Bank's statement as to any deficiencies being accepted.

330. The whole system followed in the Cash Office was simple in the extreme, the check seemed all that was necessary, and the saving of labour effected both in the Cash and in the Audit Offices was very appreciable.

System good and economical.

CAR RECORD.

Record of movement of wagons. System followed in India.

331. When a train has been made up, the usual practice in India is for a Vehicle Guidance or Summary to be prepared by the station staff, in which are shown the number of every vehicle, station from and to and route, and, where the load of the engine is calculated on the weight, the gross weight of the vehicle. This guidance is made over to the guard, who checks over his train, and then signs in the station books for the wagons on it. A column is provided in the guidance against each entry for receiver's signature, and the guard is required to obtain signature here for every entry in the guidance. At the conclusion of his run, he submits the guidance to the office of the District Traffic Superintendent attached to his report for the train.

If at any time it is required to trace a vehicle, enquiry has to be made of the train by which it was despatched from the station of origin, and of every engine station through which it should have passed.

The guidance is then examined to see the condition in which it reached its destination, or if it has not reached there, where it lies.

It is never possible to say straight off where any particular wagon is, and much delay and telegraphing are necessary before a wagon can be traced. Meanwhile enquirers are kept waiting indefinitely for information about their goods.

The whole system is cumbersome, slow, and unsatisfactory.

American system permits trace instantly.

332. To get over this difficulty, every railway in America maintains what is called a Car Record at the headquarters of the railway, in the office of the General Superintendent of Transportation, by means of which it is possible to say in an instant where any particular wagon is, and to trace every movement of it from the time it was put on the road.

The system employed on every railway is the same in principle, but the details differ considerably, and a great deal more energy and time and consequently money are spent in the maintenance of the record on some railways than on others.

Simplest on Great Northern Railway.

Guards report foundation.

333. The simplest and most effective system I found in force on the Great Northern Railroad (Mr. James J. Hill's line), and perhaps Mr. Hill will forgive me for giving it away.

It was as follows:—At the station from which a train starts a form of "Freight Conductor's Wheel Report," is handed the guard (lines are ruled, and each line is numbered from 1 onwards, and each wagon has one line allotted it) in which there are columns for Initials (of car), Kind (of car), No. of car (there are six dotted lines running down the column to keep each figure in the number separate), $\frac{\times}{-}$ ($\times$ means loaded, and — empty), Taken at, Left at, Contents, Destination, Light weight of car, Weight of contents, Gross weight, Engine rating, Security (condition of seals), side door, end doors, and lastly the Number of miles run by the vehicle on the train.

Stations are represented all over America by figures, so that the columns Taken at, Left at, and Destination, are wide enough for four figures only.

At the foot of the form is an abstract giving total number of cars loaded and empty, and totals of columns of weight.

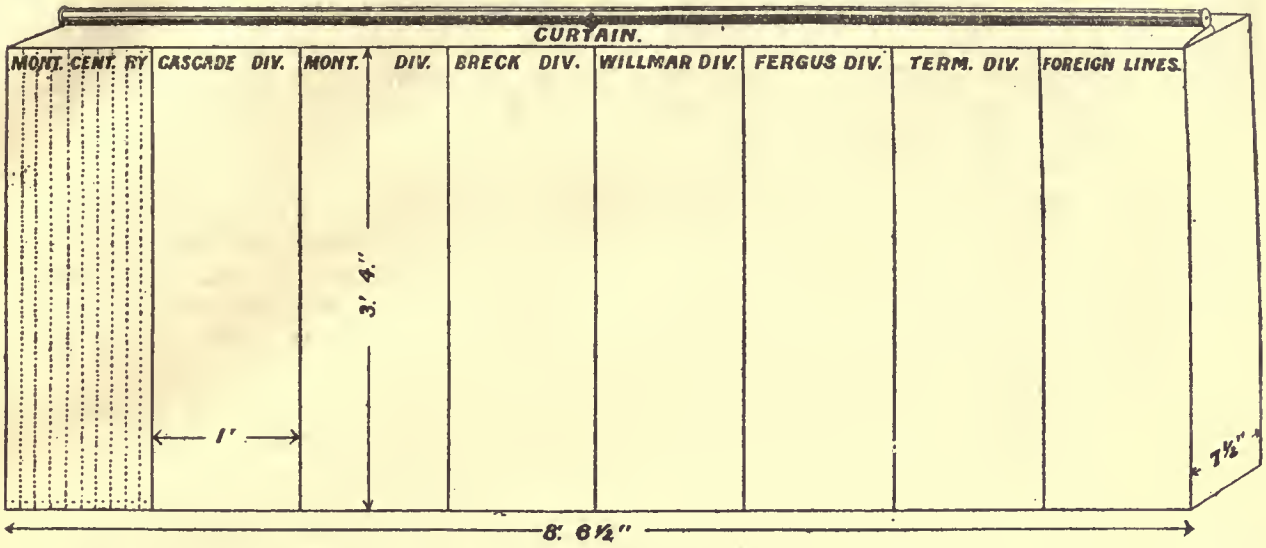
The form provides room for 100 vehicles, part in front and part at back, and on the back there are columns to show the Engine No. and its authorised rating, and the date and time of arrival at and departure from each station without explanation of delays.

If any wagon has been badly damaged or destroyed on the journey by accident a circle is placed round the *Line No.*

This report the guard of the train himself prepares, entering the wagons in the order in which they stand beginning with the engine, and at the end of his journey he hands it over to the Train Master, who submits it direct to the General Superintendent of Transportation at the headquarters of the railway.

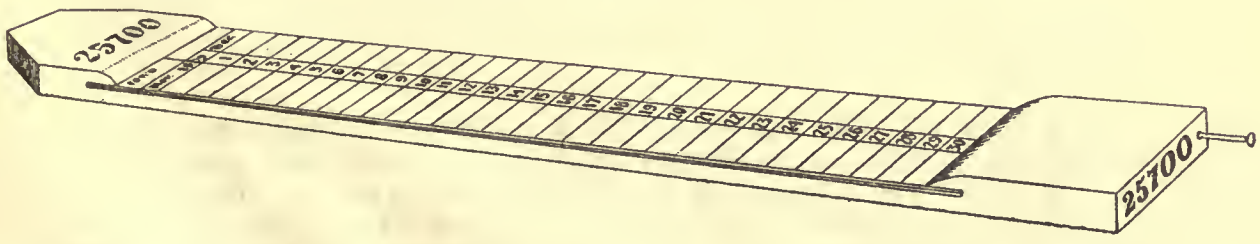
Arrangements for dealing with report at headquarters.

334. In the office of the General Superintendent of Transportation, cupboards are provided, containing compartments for each District as shown in the following diagram:—



Each compartment is again subdivided into 10 compartments by thin wires, the compartments representing the figures 0 to 9 in sequence, in which are placed slips for wagons whose numbers end with these figures. There are four such cupboards, each in charge of one clerk, among whom a series of wagons according to numbers are divided.

335. In the Car Record Office the number of each wagon is printed on to the face and end of a wooden slip, measuring 8 inches long, 1 inch wide, and ¼ inch deep, and shaped as follows:—



336. Each series of wagons is given a colour (the different types of wagons are numbered in one series) and the wooden slip is painted this colour, so that the *class* of a wagon can be told at a glance. Inside the wooden slip are inserted three card slips of the same width as the wooden slip, on which are ruled, front and back, 31 lines, with the dates shown thereon down a central column and the names of two months on either side at the head of the column as will be seen from the foregoing diagram.

Each class of wagon given a colour. Paper slips show movements.

These slips, therefore, contain a whole year's work. At the close of the year they are replaced by new slips, and the old ones are filed away in draws for future reference.

337. On receipt of the guard's report in the office of the General Superintendent of Transportation, a clerk goes through it wagon number by wagon number. If any of the wagons are in his cupboard, he records on the card slips opposite the date of the train, the figures representing the station to

Clerks mark off on card slips movement of every wagon

which the wagon has been moved, ticks off the entry in the report, and passes it on to the next clerk. If the wagons have moved from one District on to another, the wooden slip is put back in the compartment of the District on to which it has gone. The whole labour involved is the pulling out of the wooden slips, which is facilitated by the pins at the end of them, the entry of three figures in the card slip, and the return of the wooden slip to the cupboard, an operation which takes less time to perform than it does to describe.

Advantages of cupboard arrangement.

338. The division of the cupboards into Districts shows what the distribution of stock is on the line ; the sub-division of the compartments by figures, simplifies the finding of any wagon, and the colouring of the wooden slips makes it possible for any one to tell at a glance what the different kinds of wagons are on the District.

Tracing of movement of wagons.

339. When a wagon needs to be traced, a reference is always made about it to the General Superintendent of Transportation, never to stations ; its number indicates in which cupboard it will be found, and by running down the sub-divisions for the terminal figure in the number, the wagon can be traced without any delay. The card slip then shows where it was up to the last report received of its movement. As the reports come in by fast trains and reach headquarters within 48 hours of the train finishing its journey, the movements of all wagons are known to within 48 hours.

Card slips examined to check detentions.

340. After all the guards' reports have been posted, the clerks look over every wooden slip to check detentions, and if any wagon is found to have been more than five days at any station, enquiry is at once made of the reason for the detention.

Procedure in regard to Foreign wagons.

341. Foreign wagons cannot, for obvious reasons, be dealt with in this way, and the record of their movements has to be kept in registers. These registers have a column for Car No. each page subdivided by figures which represent the terminal figure in the number of the wagon, and a column for movement which is subdivided opposite Car No. by a line for date and lines for movement. Each railway with which wagons are exchanged has a separate register. The method is cumbersome, but in the absence of the cupboard system, the most expeditious and the cheapest than can be devised.

System applied to home vehicles on some railways.

342. It is this latter system which is applied on most railways to home wagons as well, and one railway I was given to understand employed no less than 160 men to keep the record for its large system. The details of its methods are organisation perfected, but it could obtain the same result with only a small fraction of the present expenditure by the adoption of Mr. Hill's method.

Car Record system excellent.

343. The idea of Car Record as developed by Mr. Hill impressed me very greatly. It is simple, it is expeditious, it is economical, and any expense incurred in its up-keep would be more than covered by the saving of inconvenience and delay which the present Indian practice involves.

Similar record kept for engines.

344. A somewhat similar record is kept on the Great Northern Railway of engines, each class of engine being represented by a different colour, so that it is possible to see at a glance how the engines are distributed over the line.

Guards' reports used for statistical information.

345. After the clerks have finished posting the Car Record, the guards' reports go into the Statistical branch of the same office, and the engine, vehicle, and train mileage, and numerous statistics bearing thereon, are

then calculated by trains, by Districts, by Divisions, and by railway. When completed, these results are presented to the several officers concerned, and are in their hands, on one railway, by the 15th of the month following that to which they relate. The Superintendent in charge told me it was hard work to get them ready by this date, but they had never yet failed to be up to time.

Much importance attached to fast freight. Track kept of its movement by telegraph.

346. In America, the greatest importance is attached to "Fast Freight," which comprises not only perishables, but a large proportion of all less than car load traffic. As previously stated, it is always sent by fast trains. The movement of these trains is telegraphed to the General Superintendent of Transportation as they leave each engine station, and a careful record kept of the wagons on them. It is thus possible for a consignor or consignee, by reference to the office of the General Superintendent of Transportation, to know without any delay, exactly where his goods are and when they may be expected to arrive. This enables him to make closer calculations, and to conduct his business more closely up to date.

Daly's Car Record system explained.

347. Every railway follows this practice, but the best system is that devised by Mr. T. M. Daly, of the Illinois Central Railroad, which is as follows:—

Fast freight is invoiced in the ordinary way, but a special label is attached to the wagon containing such goods for the information of the yard staff.

The invoices for such wagons are placed in special envelopes, a separate envelope being used for each wagon; and these envelopes remain with the wagon until it reaches its destination.

348. Immediately a train with fast freight starts, the station of origin sends a telegram to the office of the General Superintendent of Transportation, giving the individual number of each wagon in consecutive order beginning from the engine, with the particulars of load, destination, and time of departure.

349. To reduce the length of telegrams each station from which trains start is represented by a letter, the stations of destination by figures, and the various heads of information by code abbreviations. Each line in the form in which this is reported and recorded at Chicago is numbered consecutively, and these numbers are subsequently used to distinguish the wagons instead of the numbers they bear.

350. As the train passes each engine station a telegram is sent reporting its arrival and departure, and whether all the wagons have arrived which left the last point. This is done briefly, thus: C 1 to C 20 arrived 6 a.m., left 6.15 a.m. C here represents the station of origin, and 1 to 20 the numbers representing the several wagons.

If any wagon has been detached on the road the telegram would read, C 1 to C 2, C 4 to C 20, which would mean that the wagon represented by C 3 had not been received.

351. In the office of the General Superintendent of Transportation there is a cabinet in which are sorted pegs, some numbered from 1 upwards according to the number found necessary, and others marked with letters representing the different stations. There are also small square or train boards with holes drilled in them about one inch apart. Pegs corresponding with the numbers representing the wagon are inserted in this board, at the head of it being placed letters to show the station from and to which the train is travelling.

352. Each of these train boards represents one train, and they are hung up on a larger board which represents the whole line and measures 25 feet

long. On this latter board the names of the engine stations are written down the centre of the board from top to bottom, the stations being grouped by districts; the upper half of the board is used for trains in one direction, and the lower for trains in the opposite direction. Several hooks are screwed into this board, on which are hung the train boards. As advice is received of a train having passed a station, the train board is moved down to the hook opposite that station.

353. If a wagon is detached *en route*, the peg relating to it is withdrawn from the train board and placed in a hole on the larger board opposite the station which it did not reach.

354. About 850 wagons of high-class freight are moved from different points on the Illinois Central Railroad daily, but, under the Daly system, one man is found sufficient to keep a record of all their movements; and at any time anyone can tell, by looking at the board, exactly where each wagon is.

355. A record is further kept in a register of the movements of all fast trains; and, to keep the staff up to the work, at the end of each week a statement is prepared showing the average running time of each train in each District, the time that should have been taken, and the delays at stations.

356. The system of dealing with "Fast Freight" in America has been found necessary for the conditions of the country, and though it necessitates a good deal of telegraphing to a central office, it has advantages in increasing the confidence of the railway's constituents and in stimulating the staff generally to smartness, which more than compensate for the labour involved.

CHAPTER X.

LABOUR SAVING DEVICES.

Hollerith Electric Tabulating Machine. Appendix C.

357. Of all the labour-saving devices used in offices in America, the most remarkable is the Hollerith Electric Tabulating Machine, of which a full description will be found in Appendix C.

To describe it briefly, holes are punched in a card to represent different things, names of places, names of things, weights, amounts, distances, or anything else that requires tabulation. The cards are then passed through a machine, or series of machines, and they produce any result which is desired.

For railway purposes the machine has only been in use a short time, and only one railway, the New York Central and Hudson River, has had it under trial. Since its adoption the cost of the work done by it averages $3,940 or Rs. 11,820 monthly, and the saving over the old methods is estimated at $1,050 or Rs. 3,150 a month.

In reporting on the machine, the officer in charge of the department where it is being tried, said :—

> " In the first place, I want to say that, regardless of any difference in cost, conditions being equal, it would be a serious mistake to abandon the use of the machines for two reasons alone—
>
> " First, the wider possible application of the machine methods, at a minimum cost, to statistics;
>
> " Second, the elasticity of the machine methods to varying conditions in arriving at revenue results."

I spent a considerable time in watching the working of the machines. The system is capable of almost any combination so long as numerals are used to represent things, and its value in any office where large masses of figures have to be totalled cannot be exaggerated.

I enquired of the patentees (the Tabulating Machine Company, 1,054, Thirty-first Street, Washington, D. C.) what the cost would be of a set of machines, and they inform me that they hope to have ready very shortly an improved form of sorting and tabulating machine, when prices would be quoted. They, however, do undertake to supply the machines free of cost, so long as the punches are purchased from them as also the cards required by the system. The cost of the cards is $1 or Rs. 3 per thousand, but is less where large quantities are taken. The machine is, of course, made to record American money, but could be adapted to any other form of currency.

Brunsviga Calculating Machine.

358. Perhaps the next in ingenuity of design is the Brunsviga Patent Calculating Machine. It is slow for purposes of addition as compared with a machine I shall presently refer to, but for multiplication, division, subtraction, extraction of cube and square root, and similar results, it is most useful. You can multiply ten figures by nine figures, and can divide the same number, so that there can be no doubt of its suitability for general use.

The New York Central had one of these machines on trial. I wanted some statistical information which, when ready, covered two sheets of double foolscap paper. The calculations necessary to prepare the statement were numerous and varied. The work was given to the clerk in charge of the Brunsviga, and he told me he could not have done it in twice the time without the machine, and would then have been mentally worn out. As it was, he had felt no mental fatigue whatever. The machine is absolutely accurate, is not difficult to manipulate, is simple in its mechanism, and one great advantage about it is that the operator has a constant check on his work, for there is a tell-tale in the machine to show him what each operation has been. The machine is supplied in two sizes, 14½ ins. and 9 ins. long, and is sold in New York for $200 and $160 respectively. The larger

is the better size for use in a railway office. It is a German invention, and the name of the manufacturers is Grimme Natalis & Co., Limited, Brunswick. The New York Agents are F. F. Schaefer, 19, Park Place.

Burrough's Arithmometer and Registering Machine.

359. For purposes of addition, the Burrough's Arithmometer and Registering Machine was the best I saw. It is somewhat in the form of a type-writer, and not only adds figures but records all those added together, so that it is possible to check the work after it is finished, which is not possible with any other kind of adding machine.

Multiplication can also be done on it, but the process is slow. I was not able to ascertain the price of the machine, but it is sold by the Burrough's American Arithmometer Company, St. Louis, Mo., who have agents at Nottingham in England.

Hektograph.

360. For reproducing documents, the Hektograph machine is very largely used. The reproduction is done on gelatine, and so long as this is kept moist, I was told that it was not affected by heat. An indefinite number of copies can be made, the last as clear as the first. The machine is simple and quick in operation. It is sold by the Hektograph Company, 42, Murray Street, New York.

Edison electric pin.

The Edison electric pen is used for the same purpose, and is effective and suitable for the finest kind of work.

Boyer's Speed Recorder.

361. Boyer's Railway Speed Recorder. This is a useful machine for recording the speed at which trains are travelling. It is sold by the Chicago Pneumatic Tool Company, Fisher Building, Chicago.

Type-writers.

362. Type-writing machines are now used very extensively in America for typing direct into books, as the expedition and neatness of the work are so much greater than work done by hand. The Elliott and Fisher Company Philadelphia, Pa., have a large assortment of these machines suitable for every conceivable kind of work.

Perpetual ledgers.

363. The use of bound books for accounting work has to a very large extent been superseded by what are called Perpetual Ledgers.

The perpetual ledger is a mechanically constructed binding fitted with a lock, into which loose leaves can be inserted or from which they can be removed at any time, thus avoiding the keeping of dead matter mixed up with current matter and the waste of a good deal of space. In the case of accounts, at the end of the month, or other period when accounts are balanced, the leaves can be withdrawn and the work distributed among several clerks, an arrangement impossible with a bound book. The leaves of closed accounts can at the same time be removed and separately filed, the recurring accounts under each head or of each person being always kept together in one place.

This form of ledger is now kept not only in railway offices, but in banks also, as it is considered to have numberless advantages over bound books for all classes of records. It saves time and labour, is self-indexing, carries no dead matter, and allows of indefinite expansion without re-arrangement or re-writing, and eliminates the labour and expense of opening new books at the beginning of each year. No inconvenience has been experienced from its use, and the universal adoption of the system in all railway offices by both accounts officers and others is testimony to its merits. Of course, leaves might be removed by dishonest persons, but little matter that would go into these ledgers is without a duplicate somewhere, and the risk of abstraction is so small as to be held not worth consideration.

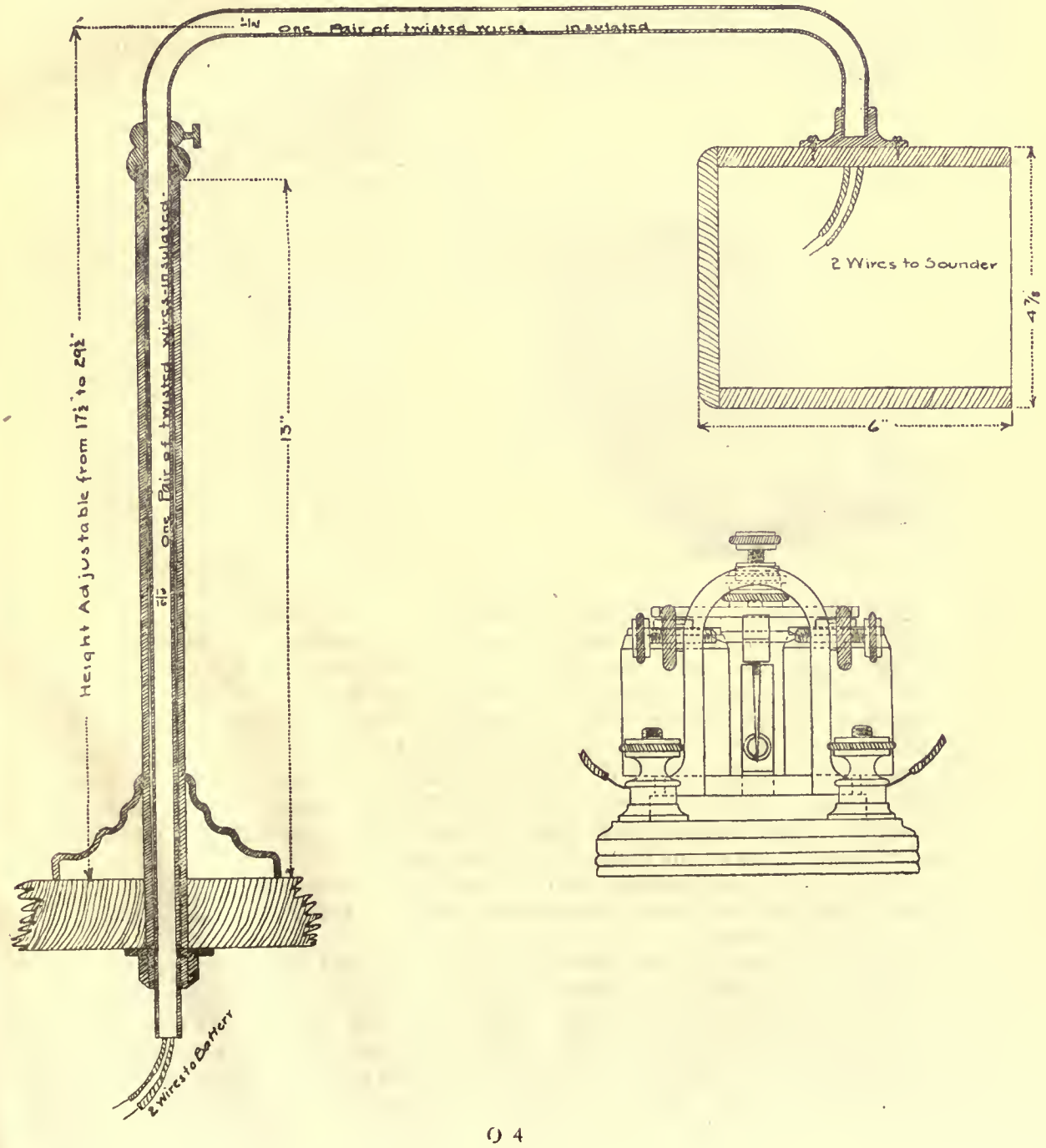
These books are supplied by the Jones Perpetual Ledger Company, New York Life Building, Chicago. The initial cost of them is high, but it has been estimated that, over a series of years, the expense works out to less than bound books.

Rapid Roller Letter Copier.

364. For press copying letters, the ordinary hand-screw press has been superseded by the Rapid Roller Letter Copier. The copies are taken on a continuous sheet of tissue paper, which unwinds from a roll, and after copying, winds up automatically on a roll in the base of the machine. When all letters have been copied, the tissue paper is removed from the reel and the several letters separated. It copies letter after letter continuously, as fast as the machine can be fed. No time is lost in wetting the sheets, turning pages of letter books, or waiting for a press to do its work. It is quick in action and satisfactory in performance, and a great saver of time. It is sold by the Library Bureau Company, who have a branch at 10, Bloomsbury Street, London, W.C.

Resonator and Sounder for Telegraph Instruments.

365. At headquarter stations of all District Superintendents, and at other offices where the number of telegraph instruments is large, the key of the Morse Telegraph instrument is detached from the sounder and fixed to the table, and the sounder is placed in a box raised from the table, which works on a pivot and can be moved close to the ear of the operator. The following is a plan of the arrangement :—



The operator is further supplied with a type-writing machine on which he takes down all messages. With this arrangement, six instruments can be placed on a table 6½ ft. × 4 ft. without the operators being disturbed by the sounds of the other instruments, and the operator is able to receive more rapidly than he could if he had to record the messages in manuscript.

Card Index System.

366. While the Hollerith Electric Tabulating Machine was the most remarkable labour-saving device I saw in America, the most useful perhaps was the Card Index system, which is now used for every conceivable kind of work.

The Card Index system is a method of keeping track of facts, figures, names or data of any sort, by means of cards of uniform size, ruled or printed to accommodate the particular data required, and arranged on edge in a tray or drawer, alphabetically, numerically, territorially, chronologically or in any other way that will best meet the particular requirements.

In railway offices it is chiefly used for the registering and recording of correspondence though it is also used very extensively in workshops and elsewhere for various other kinds of records. The system requires a small cabinet with two or more narrow drawers according to the amount of business. Into these drawers fit the cards, which, in the case of correspondence to be registered, are consecutively numbered; but which are arranged in the drawer, as a dictionary is arranged, in alphabetical sequence.

To keep the different letters of the alphabet or groups of such letters separate, guide cards are provided, which project at the top above the cards and indicate what letters will be found between it and the next guide card in the box. The guide cards are to a card system what references at the top of a page are to a book. They mark definite locations in the cards and ensure the speedy finding of any particular card which may be sought.

Both the index cards and the guide cards are kept in position by a rod which passes through them from end to end of the drawer, so that they can never be shaken out of place.

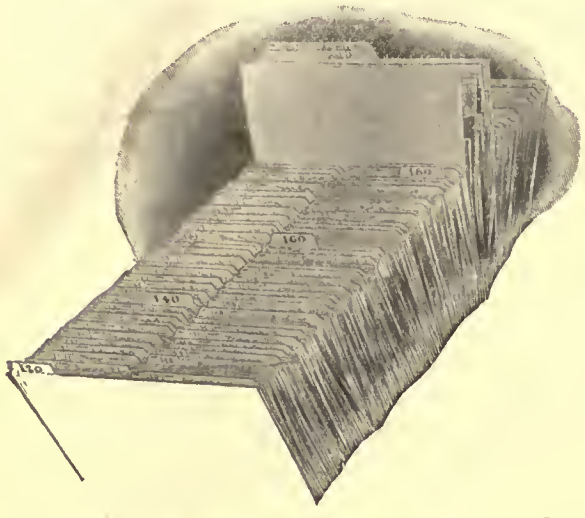
The diagram in the margin will perhaps make the system clearer.

In *registering* correspondence, on receipt of a letter, a reference is made to the drawer to see if the subject has been previously registered. If it has not, the next unused card (these are kept in a separate place arranged in consecutive order according to their numbers) is taken, the *subject* of the letter entered on it and the card inserted in its proper place in the drawer according to alphabetical sequence. Where the subject is not quite clear, it is entered under the several heads under which it might be classified, blind cards, that is, cards without numbers, being used on which reference is given to the main card and its number.

Where the correspondence is important, the case may be registered in a book, being given the same number as in the Card Index, but this precaution is not usually taken.

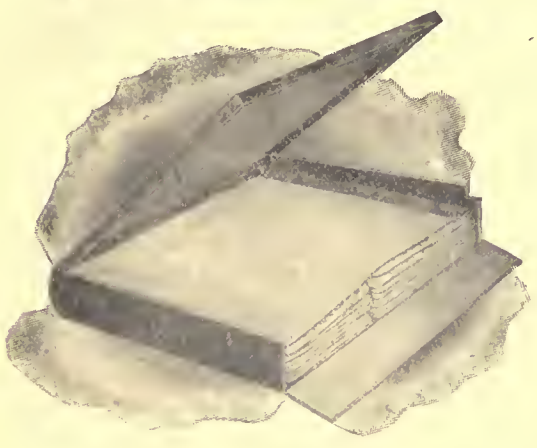
For the *recording* of the correspondence, a separate and larger cabinet is provided. This cabinet is divided into compartments of suitable size into which fit folders bearing the same number as the index card; and within these folders the "case" is inserted, guide cards being used to keep groups of numbers separate. When a "case" is removed from this folder, a memo is placed in it to show where the "case" has gone.

When the correspondence on one subject is very voluminous, it can be divided among several folders, all bearing the same number but each folder devoted to the correspondence covering a certain period of time. In such cases, the folders would be marked with the period covered in addition to the number, and filed one in front of the other, the latest period being to the front.



The diagram in the margin shows how the cases are recorded.

In transferring the contents from the cabinet files when full, periodical transfers of the entire contents can be made, or the contents of the crowded files can be relieved from time to time by transfer of the least important and out of date matter.



Transfer Case.

In transferring, the folders with their contents may be removed, or the original folders can be left in the files and the contents placed in other folders properly numbered, and placed in transfer cases in numerical order. Where the entire contents of a cabinet are transferred at stated periods, the transfer cases are numbered on back to indicate the folders they contain, also date of transfer. No record of transfer is then necessary on index card or folder. The usual and better method, however, is to transfer at convenient intervals the oldest and least important correspondence, and when such transfers are made the number of the transfer case and date of transfer is noted on the index card to each folder transferred or on the folder itself, if left in the file. These transfer cases are numbered consecutively, as filled, from one up. By this method the index card, or the folder, shows at a glance exactly where to find any or all correspondence wanted. The cabinet then contains practically only correspondence that is alive or that is likely to be referred to, while the transferring can be done at odd moments without interference with other work.

When correspondence is again begun on the subject whose folder has been transferred, another folder is assigned it, still bearing the old number, and is given its proper location in the file. No record of this is necessary on the index card as the number of the folder remains unchanged.

The Card Index system is simple and much cheaper than the book register used in India, and it is infinitely more expeditious in operation; but what is of much greater importance, a case can be traced in a few seconds, where under the register system, many

registers might have to be searched through and always much time would have to be spent in examining entry after entry to find the one wanted.

For the keeping of notes on important subjects, it is invaluable. Anyone who has kept a collection of cuttings, knows how difficult it is to lay one's hand upon the particular cutting wanted, without the expenditure of much labour and trouble. An index does not help much, because it so constantly needs revision, and few busy men have time to prepare one. By the card index system, these notes could be classified and indexed with the expenditure of a very small amount of time, and could then be found when wanted without delay and trouble.

In connection with the card index system of registering correspondence, Mr. W. H. Williams, Assistant Secretary of the Baltimore and Ohio Railroad, has devised an ingenious method for sub-dividing correspondence under its different heads and sub-heads. It is based on the decimal system, and is fully described in a book which he has published entitled "Railroad Correspondence File," which is sold by the Lord Baltimore Press, the Friedenwald Company, Baltimore, Ind., the price being $5 or Rs. 15.

There are several companies in America which supply the cards and cabinets in connection with the Card Index System. The Globe-Wernicke Company has a branch in London, as also the Library Bureau Company, whose office is at 10, Bloomsbury Street, London, W.C. They all issue very full descriptive catalogues and price lists.

Labour-saving devices save the brain and insure accuracy.

367. Of course the devices which I have enumerated, do not by any means exhaust all the labour-saving devices in use. They are to be found in every branch of the railroad business, and while tending to economy of time and labour, they also have the much greater advantage of saving the brain. A man can, for example, work on a Brunsviga, all day long, turning out accurate work all the time, and may perhaps be physically exhausted at the end of the day. Whereas a man working in the ordinary way is not only physically exhausted but he is mentally exhausted too, and the accuracy of his work cannot always be relied upon after he has been many hours at it. The importance of this cannot be over-estimated, especially in a country like India where the climate tends to make the brain dull and work has generally to be done at high pressure.

CONCLUSION.

368. In conclusion, I desire to express my thanks to the Government of India for the opportunity they afforded me for studying American railway methods. It was a most interesting and instructive experience. The railways of America are commercial undertakings on a gigantic scale, and are operated under conditions which are to be found nowhere else in the world, since they receive no protection from the State, and have had to fight their way to the front by sheer ability of management. If I have appeared enthusiastic at times, it is because I was greatly impressed by the courage with which the railroad officers have faced their difficulties and the pluck with which they have overcome them. It is impossible to associate with the great men who have made their mark on American railway, I may say American national, history, without being infected with some of the enthusiasm they show for their business; and no man can travel over their railways without becoming possessed of a great deal more knowledge than he previously had, or without getting many valuable hints. Many of their methods are different, often startlingly different, from those one has been brought up to believe the only correct method; and it is not till one realises that the one idea in the mind of American railway men is to "get there," and that they do "get there" by the shortest and quickest way, and do not allow themselves to be turned aside either by red-tape, old-time-prejudices, tradition, or any other of the bogeys by which older countries are assailed, that one understands how the results have been obtained which one sees there. American railway men are quick to see a new idea; they are quicker still to try it; they take a great pride in their profession, and are all striving to get at the science of it. That their methods are not always perfect is what might have been expected; but they have managed to do what no other country in the world has done, and, that is, carry their goods traffic profitably at extraordinarily low rates notwithstanding the fact that they pay more for their labour than any other country. It is in the study of how they do this that much benefit can be derived by other countries; and if I have, in some degree, succeeded in throwing light on their methods, I shall feel that I have benefited others as well as myself by my visit to that great country where the courtesy of the people is only exceeded by their hospitality.

Neville Priestley,
Under Secretary to the Government of India.
Railway Department
(on leave).

London,
30th December 1903.

APPENDICES.

APPENDIX A.

Description of Dr. C. H. Williams' Lantern for testing Colour-Blindness.

The lantern has on its face a single disc with 18 coloured glasses, and within the lantern two lights and a shutter so arranged that either two or one of the coloured glasses can be illuminated at one time. By revolving the disc all the colours can be brought before the lights in succession, and it is found that with two lights showing at one time, a person with defective colour-perception is often more confused, than when he has only one coloured light to look at; for instance, with a light and a dark red, he will often call one of them a green and the other a red. The shutter, besides regulating the lights as single or double, also changes the area, so that two lights with the full opening, half size, or the smallest opening, can be shown, or one light of each of these sizes. Under each coloured glass in the disc is an opening with a transparent number, which is lighted at the same time as the colour above it. This number can be seen by the examiner, but is screened from the person examined, and by means of these numbers a record of the examination can be kept, the number under the colour and the name given to this colour being noted as the examination proceeds. The lantern is placed in a dark room 20 feet from the person to be examined, and on a level with his head. The area of the largest opening at this distance then corresponds to the apparent size of a standard signal light at a distance of 160 feet, and the smallest opening to such a light at a distance of 1,300 feet.

In addition to the test with different coloured lights, it is important that the test should be made with a light whose intensity can be varied by fixed amounts; for in some cases those whose sight is defective depend on the intensity of the light to distinguish between red and green. For this purpose, the light, by means of a handle projecting through the door at the back of the lantern, can be varied, and the candle-power of the lamps can thus be reduced or raised by fixed amounts at pleasure. This lantern test is used *in addition* to the Holmgren worsted test. If a person calls red green, or green red in the lantern test, or selects confusion colours with both the green and the rose-test skeins, he is rejected as showing an unsafe degree of defective colour-perception.

With these two tests carefully made, it is reasonably certain that no dangerous case of defective colour-sense will be passed. In cases where the trouble is due to an acquired defect, as from the excessive use of tobacco, a considerable improvement may result from stopping the tobacco; but in the congenital cases no treatment will be of much use. Some men can learn by constant practice to give the correct names to certain colours, or even to select correctly the proper colours in a given set of worsteds, but when tested with new colours that they have not previously seen and practiced with, they will generally be unable to recognise them correctly.

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APPENDIX C.

RECORDING WAYBILL STATISTICS BY MACHINERY.

(*Reprinted from the Railroad Gazette of 4th July* 1902).

In the United States Census of 1890 it was demonstrated that statistical facts relating to a person or a farm could be transcribed to a punched record card, and that these facts could then, with great economy of time and labour, be tabulated by means of mechanical devices, producing any desired statistical result. This led to the suggestion that a punched record card be used in a railroad auditor's office, in place of a written transcript, to preserve the facts pertaining to a waybill.

2. This fundamental idea was presented to the officials of the New York Central and Hudson River, and after a number of years of experiments a system was finally developed which it is believed may have far-reaching results on the method of auditing freight accounts and compiling statistics relating to freight traffic.

3. In establishing the new methods the Company adopted, as the primary record for the general office, a daily agent's forwarded and received report. This was adopted because, so far as the work of the auditor's office is concerned, such a daily report lends itself as readily to mechanical treatment as a monthly report, and a daily report possesses advantages to the agent—

(*a*) In entering his waybills he simply enters them as they come in, and does not in addition, have to find the place where they are to be entered.

(*b*) In getting his totals for the month he simply adds 25 daily totals, whereas in a monthly system he must develop his waybill items by as many totals as there are station-to-station groups in his billing.

(*c*) He is able to know as soon as the last bill is entered on his received register, just the exact amount of the debit against his station from this source. In the other case he does not know until the end of the month; or if he wishes to know daily, he must multiply his station-to-station totals by 25 (approximately) to develop them by days in order to balance daily.

4. In the Auditor's office, we start with the daily received report, one from each station. These reports are given to clerks who transfer day by day the facts concerning each way-bill, as found in the received report, by means of a simple little machine illustrated in Fig. 1, to a card printed as shown in Fig. 2.

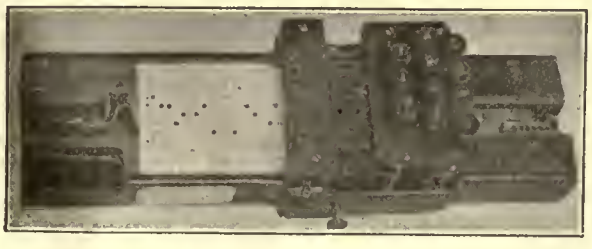

Fig. 1.—Card Punch.

5. The punching machine, Fig. 1, is provided with ten punches, each operated by one of the keys numbered from 0 to 9, and an additional punch and key marked X, the purpose of which will be explained later. The card is inserted in the punch by the operator until the fourth vertical printed row from the left is directly under the punches. The clerk

APPENDIX C.

Hollerith Tabulating Machine.

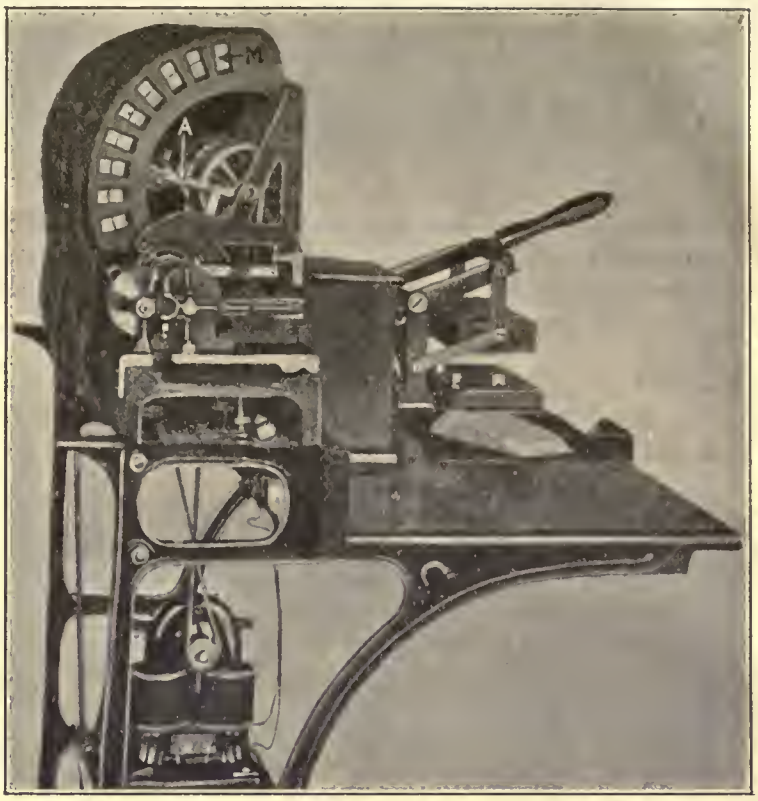

Fig. 5.—Side View of Tabulating Machine.
A, radial arm; M, magnets.

forwarded, and properly filed in suitable cases. After a certain length of time, long enough to get all the bills in, the cards corresponding to the first day's forwarding are tabulated in the tabulating machine, and the total so obtained for each station is compared with the agents' forwarded reports. If the machine total agrees with the total of the agent's report, it shows that every waybill reported forwarded on that report has been properly taken up by the receiving agent. In the case of discrepancy in these totals the cards are arranged in numerical order, according to the number of the waybill, and the amounts checked, bill by bill, until the discrepancy is accounted for. Sometimes such discrepancies are due to difference between the amounts recorded on the cards, or, in other words, the amount reported by the receiving agent, and the amount reported by the forwarding agent. In such cases these discrepancies are noted on a so-called "difference sheet," and, according to the decision of the Auditor, either the received or the forwarded report is changed accordingly; the card in the meantime being changed, if necessary, by covering the punched holes with little pieces of court-plaster and punching the correct amounts, the pieces of court-plaster corresponding to red ink. Should the discrepancy be due to the fact that a card is found which is not on the forwarding reports, such card is laid aside and marked as "not found" on the particular day; or if a waybill is reported on the forwarding report for which no corresponding card is found, a note of such missing card is also made on an "on and off" sheet. It frequently happens, of course, that the receiving agent reports the wrong date forwarded, which is usually detected by the number of the waybill, and when the waybill to which the card refers is located the date is changed accordingly and the card put in its proper place. The checking in this way commences a few days after the first of the month, and is kept up until the business for the month has been properly checked. The cards are then all corrected, and the corrections are made on the reports.

12. The cards are now run through the machine to obtain the total month's business for each forwarding station, and for the larger stations the total is

noted for each day's business. If all the corrections have been properly made, the total so obtained from the cards must tally with the corrected agent's forwarded reports. The cards are then sorted according to the received stations, and subdivided according to stations from which forwarded, and in these station-to-station groups the cards are run through the machine; thus obtaining a total for the business done between any two points during the month, and giving what are known in the office as "monthly summaries." In this way we also obtain the total of the business received at each station during the month, thus checking the corrections on the agents' received reports. From this summary the ton-mileage is obtained.

13. It will be noticed that we have individual cards, each representing one waybill; and these cards can be shifted rapidly from one grouping or arrangement to another, and can be rapidly added to obtain the different desired results.

14. In sorting the cards the only implement used is a knitting needle. Often a considerable number of cards can be lifted off at one time, the corresponding hole being punched through all such cards. The sorting can be done rapidly because no particular care need be taken; for after the cards have been sorted, the correctness of the sort can be determined by simply aligning the cards when the corresponding hole should appear through all the cards. This can be tested with a knitting needle, or else by holding up a bunch of cards and looking through the proper hole.

15. To illustrate the possibilities of the use of a punched card of this kind, if we have punched in the card (1) the number of miles corresponding to the movement of the waybill, and (2) the commodity, it becomes a very simple matter to obtain the earnings per ton per mile for the different commodities; for it is only necessary to sort the cards according to commodities, subdivided according to mileage, and tabulated accordingly. This tabulation could then be done entirely irrespective of the points of origin and destination. Again, if it is desired to know the earnings per ton per mile on long hauls, as compared with short hauls, this information is at hand by simply arranging the cards according to miles. The cards, if desired, can also be sorted according to waybills, the earnings of which were between certain limits. We can obtain the earnings per ton per mile on waybills originating in certain territory or destined to certain territory.

In fact, any desired information can be obtained from these cards that is shown by the data on the card.

16. In the foregoing we have treated the waybill as the unit. If a given waybill contains a number of commodities, and the commodities are to be recorded, then supplemental cards are to be used for such commodities.

17. An agent's daily report does not contain a full transcript of each item on every waybill; he lumps items together, as far as this may properly be done without interfering with the demands of the Auditor's record.

Corrections of computations are made in another office, from tissue copies furnished by the forwarding agent.

18. The facility acquired in transferring the records on waybills to punched cards is shown in the following table, which represents the work of the clerks on punching machines at the New York Central office, in New York City, during five days, with the number of hours worked each day and the number of cards punched or waybills transcribed during such time. A

column is also given to show how long the clerks have been engaged in this particular work.

RECORDS OF WORK ON PUNCHING MACHINES.

Clerk.	Number of Cards Punched.										Length of Service on Punching.
	Monday		Tuesday.		Wednesday.		Thursday.		Friday.		
	Cards.	Hrs.	Cards.	Hrs.	Cards.	Hrs.	Cards.	Hrs.	Cards.	Hrs.	
A - -	825	8¼	1,250	8¼	1,175	8¼	825	8¼	725	8¼	1 month
B -	1,250	7¼	1,475	8¼	1,175	7¼	1,500	8¼	1,225	7¼	4 ,,
C - -	1,550	8¼	1,850	8¼	1,700	8¼	1,600	8¼	1,625	8¼	9 ,,
D - -	1,850	8¼	1,250	8¼	1,050	8¼	1,750	8¼	1,550	8¼	9 ,,
E - -	1,500	8¼	1,025	8¼	1,225	8¼	1,700	8¼	1,750	8¼	12 ,,
F - -	1,125	8¼	1,450	8¼	1,275	8¼	1,250	8¼	1,275	8¼	3 ,,
G - -	1,650	8¼	1,850	8¼	1,825	8¼	1,850	8¼	1,875	8¼	12 ,,
H - -	2,200	8¼	2,350	8¼	2,350	8¼	2,100	8¼	2,425	8¼	3 ,,
I - -	1,475	8¼	900	8¼	1,150	8¼	1,500	8¼	1,225	8¼	9 ,,
K - -	—	—	—	—	400	8¼	absent		600	8¼	2 ,,
L - -	1,475	8¼	1,350	8¼	1,500	8¼	1,475	8¼	1,575	8¼	1 ,,
M - -	2,175	7¼	2,325	7¼	2,350	7¼	2,025	7¼	1,875	7¼	12 ,,
Totals -	17,075		17,075		17,175		17,575		17,725		

19. This record shows that for a uniform day of 7¼ hours the average for the entire force is 1,358 cards per clerk. The records for clerks A and K are considerably below the average, and if their records were omitted the average would be 1,448 cards per clerk per day. It is to be noted that clerk A had been engaged in this work only one month. A record of work done by this same clerk in the five days ending 20th June, shows an average of 1,370 per day of 8¼ hours, as compared with an average of 960 for a day of the same length in April. This affords an illustration of the short length of time necessary to acquire a fair degree of efficiency.

20. Fig. 2 represents a card in which has been punched the transcript of a waybill which was received 22nd May at Boston. There was no "line." It was forwarded from Barclay Street, and therefore was joint business, and was forwarded on the 13th. The last three figures of the waybill number were 995. Thousands and tens of thousands of the waybill numbers are ignored because the business of any one station does not run beyond a thousand waybills in a day. The commodity was 00, or merchandise. The weight was 430 lbs.; the freight on this shipment was $1.09. There were no advanced charges, and the amount prepaid was $1.09.

21. The letters at the extreme right of the card are, reading down, L, F, S, IS, L, P, L, P, meaning, respectively:—Local, bill originating on the line of the road; Foreign, received from foreign road; State business; Interstate business; reported on local forwarded reports; reported on passing forwarded reports; reported on local received reports; reported on passing received reports. This waybill originated on the line of the road, was interstate business, was reported on a local forwarded report and was also reported on a local received report.

22. Up to the present time the commodities have not been punched by the New York Central, but the card is arranged so that it can be done whenever desired. The three spaces or fields at the top of the card for punching mileage are not used at present. The intention is, however, to punch in these spaces the number of miles, with a gang punch, as well as the direction of motion, whether east or west, after the cards have been sorted to station-to-station groups. The mileage being punched in this way will facilitate the compilation of all statistics relating to ton miles, and will make possible the classification of the business according to long and short hauls, &c.

APPENDIX C.

Hollerith Tabulating Machine.

23. The mechanical details of the machine can be understood by an inspection of Figs. 4 and 5.

24. The punched card is $7\frac{3}{8}$ inches long and $3\frac{1}{4}$ inches wide. It stands between the agent's reports and the tabulating machine, and is the means by which the tabulating machine is made to mechanically discriminate in classifying the data borne by the card into groups, classes or categories. By the special location of a hole within the limits of certain boundary lines on the card it means one thing, and in another position it means another thing. The card having been punched with holes to signify by their positions on the card the information contained on the written agent's reports, the said card is put into the tabulating machine, where it acts as a stop diaphragm between a multiplicity of little spring-seated pins above the card and a corresponding series of mercury cups below the card. The pins are now, in a group, brought down, and those which are in line with holes in the card will descend through said holes and by touching the mercury below, will close so many separate electric circuits. Those pins which do not find holes in the card below them do not pass to contact with the mercury and do not close their individual electric circuits. Each pin and its mercury cup are terminals of a separate electric circuit passing through an electro-magnet controlling a counter or register. The pins are carried in a frame known as a pin-box. It will thus be seen that the so-called pin-box is a sort of electric permutation circuit controller, and that the circuit closed through any one counter or register will be determined by one position of a hole in a card, and another circuit through another counter by another position of a hole. This gives the machine a mechanical selective action and constitutes its mode of thinking, as it were. It is not practicable within the limits of space available to describe in detail the tabulating and adding devices. It must suffice to say that a punched card is placed below the pin-box on the subjacent table surface bearing the mercury cups shown on the right of Fig. 4, and the pin-box being brought down by the operator by means of the handle bar, the card automatically selects its counters or adding wheels as hereinafter described. To explain how the machine adds, *i.e.*, how a group of units is at one operation transferred to the adding wheel, reference is made to the rear view. For each adding device there is a series of nine electro-magnets arranged in an arc about the adding wheels. A radial arm oscillates or swings about the centre of the adding wheels, and in its sweep a pawl carried by it is made to turn the adding wheels any number of spaces according to the number to be added. This is accomplished by causing the turning pawl of the swing arm to act on the adding wheel sooner or later in the sweep of the arm. If it acts immediately on starting it turns the adding wheel nine spaces and adds 9. If it does not act until it has passed the fifth magnet it turns the wheel four spaces and adds 4. The timing of the action of the pawl on the adding wheel as the arm sweeps over the same is effected by the segmental series of the electro-magnets as follows :—Each magnet is connected to the electrodes of the pin-box, and the selection of a particular magnet in the curved series is controlled by the selective action of the punched card at the pin-box, which is made to close a circuit through any one of the magnets of the curved segment. Such magnet when energized is made to release a trip pawl that is thrown into the path of the swinging arm, and, striking an attachment thereon, causes the turning pawl of the swinging arm to engage an adding wheel and turn it a greater or less number of spaces according to the position of the magnet in the segmental series which has been energized.

25. A card to be tabulated on one of these machines is required to be placed by the operator beneath the pin-box, the pin-box depressed and the card then removed by hand. If the card is properly tabulated, a little bell rings simultaneously with the depression of the pin-box. If a card has not been properly punched the machine gives notice of the same so that the error may be corrected.

APPENDIX C.

Hollerith Tabulating Machine.

26. The little box which is seen in front of the machine, Fig. 3, beside the lamp, has the function of a controlling switchboard. In running for summaries, the pins are set, for example, to represent cards corresponding to movement of freight from Buffalo to Weehawken, or say from station 126 to station 673. As long as cards corresponding to these forwarding and receiving stations are placed in the tabulating machine the machine will operate. If, however, a card representing any other forwarding or receiving station should be placed in the machine, the machine will not operate, but the light will flash, indicating to the operator that the end of that group of stations has been reached, that a reading should be taken, the machine set to zero by pulling down the handles and the plug board or switchboard set to the next receiving station.

27. In order to facilitate the sorting of cards into groups, use is made of an automatic sorting machine, illustrated in Fig. 6. A stack, c, of four or five hundred cards may be placed in this machine, and the small electric motor, m, started. The cards are fed singly into one of 10 tracks, these tracks

Fig. 6.—Hollerith's Electric Sorting Machine.

ending over 10 receptacles, so that each card is deposited in a compartment according to the hole punched in the given row according to which the cards are being sorted. It is a simple matter to change this machine to sort different columns, and as one operator can attend to a number of these machines, the cost of sorting is reduced to a minimum.

28. The latest development of this system is the automatic tabulating machine, in which the work of separately placing each card beneath the pin-box, depressing the pin-box, and removing the card. is performed automatically by a machine instead of by hand. This automatic machine is operated by an electric motor supplied by current from the cable overhead. The cards are fed in a bunch to the top of the machine, the pin-box occupies a verticle instead of a horizontal plane, and the mercury cups are replaced by spring jacks. The machine itself successively feeds each card to the pin-box or circuit controller and tabulates its data automatically. If an improperly punched or distorted card happens to be in the lot it is automatically thrown out into a special receptacle for it, while the properly registered cards go to their own compartments.